DOCUMENT RESUME

ED 283 694 SE 048 229

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TITLE Hardhatting in a Geo-World. 3-4 Book B.
INSTITUTION AIMS Education Foundation, Fresno, CA.; Fresno Pacific Coll., CA.
PUB DATE 86
NOTE 102p.; A product of Project AIMS. For other documents in the Project AIMS Series, see SE 048 223-231 and SE 048 235-243.
AVAILABLE FROM AIMS Education Foundation, P.O. Box 7766, Fresno, CA 93747 ($10.95).
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Elementary Education; *Elementary School Mathematics; *Elementary School Science; Experiential Learning; *Geometric Concepts; Grade 3; Grade 4; Instructional Improvement; Integrated Activities; Interdisciplinary Approach; Learning Activities; Mathematics Education; *Mathematics Instruction; *Mathematics Skills; Measurement; Process Education; Science Education; *Science Instruction; Skill Development
IDENTIFIERS *Science Process Skills

ABSTRACT

Designed to emphasize mathematics skills and science processes, this booklet contains activities which provide students of grades three and four with opportunities to explore and discover aspects related to geometry, structure, and measurement. Hands-on activities are presented on skyscrapers, bridges, bubble planes, and model structures. Eighteen mathematics skills and seven science processes are listed and indexed for the six activities on structures, nine activities on measurement, and the ten activities focusing on geometric concepts. Each activity consists of student sheets and a teacher's guide. The teacher's guide contains information on the activities including: (1) topic area; (2) introductory statement; (3) math and science skills; (4) required materials; (5) key questions; (6) background information; (7) management details; (8) instructional procedures; (9) student procedures; (10) discussion questions; (11) activity extensions; and (12) curriculum coordinates. (ML)

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HARDHATTING IN A GEO-WORLD

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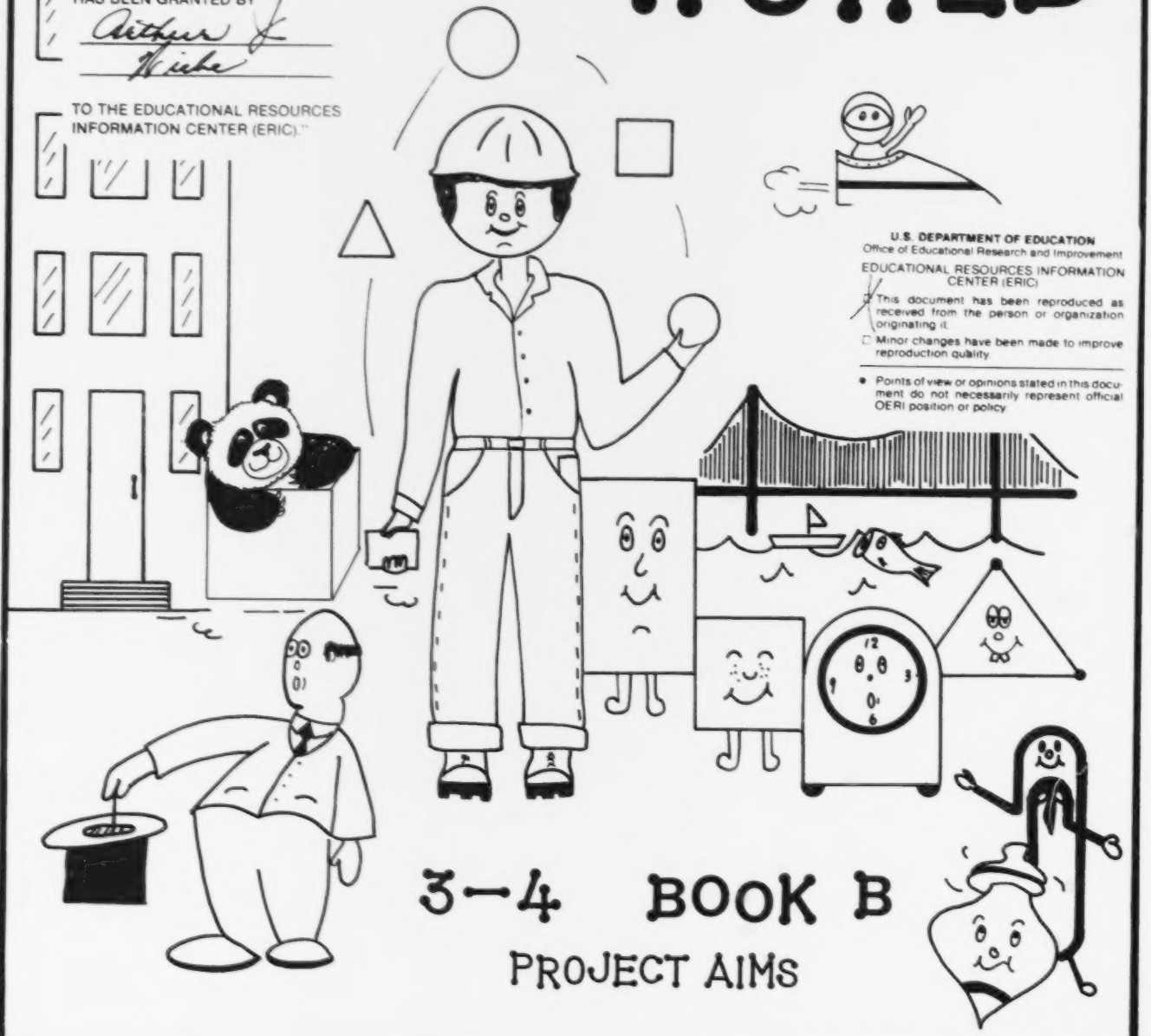

3-4 BOOK B

PROJECT AIMS

SE 048 229

HARDHATTING IN A GEO-WORLD

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Printed in the United States of America

INTRODUCTION

Hardhatting in a Geo-World bolts together math skills and science processes. Our second book was engineered to bridge the gap between isolated math and science textbook pages and the more amazing and awesome world surrounding us. The mysteries surrounding skyscrapers, bridges, one-sided paper, and bubble planes will become cemented through concrete, hands-on activities.

The geometry investigations span more than just a memorized vocabulary list or art lesson. These specially designed blueprinted activities provide opportunities for students to explore and discover hands-on geometric concepts. Children will put on their hard hats of involvement as they split milk cartons, dip shapes, and slice papers.

Through Hardhatting in a Geo-World children are hoisted into the building of model structures commonly taken for granted. As they construct and test shapes, joints, and stress they will discover and connect the important applications of math and science knowledge to our geo-world.

Measurement is an essential part of math and science education. Project AIMS provides many activities which have measurement naturally integrated in realistic settings. This book continues the integrated approach and expands measurement into a more in-depth set of activities. Space Olympics, Bear Facts, Heavy Work, and Volumes of Fun will generate enthusiasm and involvement.

We know you will enjoy building confidence and solidifying concepts of geometry, structures, and measurement through the use of Hardhatting in a Geo-World. Be creative and feel free to remodel the blueprinted lessons to fit your classroom needs and teaching style. Catch the enthusiasm and engineer your own extended projects.

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Project AIMS

Project AIMS has as its purpose the integration of subject matter in K-9. Such integration enriches and makes learning meaningful and holistic. Project AIMS began as a program to integrate mathematics and science, but has since developed to also include language arts, social studies, and other disciplines. The acronym "AIMS" stands for "activities to integrate mathematics and science."

Project AIMS is a continuing, non-profit project of Fresno Pacific College. It had its inception in a National Science Foundation funded program to train teachers in the integration of mathematics and science. This quickly created the necessity to write instructional materials incorporating this concept. Despite the fact that thoughtful educators have long recommended this approach, very little appropriate material was available.

Currently, Project AIMS is funded solely through the sale of this developing series of books. All net proceeds from their sale flow into a trust fund administered by Fresno Pacific College. The use of this fund is restricted to the support of continued research and development, partial scholarships for classroom teachers who participate in the writing and field testing teams, and the publication of the books.

Two writing teams have completed their work. The first consisted of seventy-five teachers in grades 5-9 who met over a period of eighteen months. The second involved thirty-five K-4 teachers who wrote during a two-year span. In the fall of 1985 a third team of approximately fifty teachers in grades 2-9 will begin writing. In addition, over a hundred teachers have been involved in field testing newly created materials.

The rationale for this integrative thrust lies in the fact that science, mathematics, language arts, social studies, etc., are integrally interwoven in the real world outside the classroom, from which it follows that they should be similarly treated in the classroom if we are to prepare our students for life in that world. Teachers who have used Project AIMS lessons give enthusiastic endorsement to the effectiveness of this approach.

Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. The language arts provide us with powerful tools of communication. Many of the major contemporary issues involve societal issues stemming from advancements in science. It is time, therefore, that all of us in the teaching profession take seriously using a more holistic mode of transmitting knowledge to students. It is this that motivates all of us who are involved in creating or using the integrative materials of Project AIMS. We invite you to join us in this effort.

Extensive field testing of these materials confirms the following beneficial results.

1. Mathematics becomes more meaningful, hence more useful, when it is applied to situations that interest students.

2. The extent to which science is studied and understood is increased, with a significant economy of time resulting from the integration of two or more disciplines.

3. There is improved quality of learning and retention, supporting the thesis that learning which is meaningful and relevant is more effective.

4. Motivation and involvement are increased dramatically as students investigate real world situations and participate actively in the process.

We invite you to become part of this classroom teacher movement by using an integrated approach and by sharing any suggestions you may have or investigations you would recommend. Project AIMS welcomes you!

I HEAR, AND I FORGET

I SEE, AND I REMEMBER

I DO, AND I UNDERSTAND

–Chinese Proverb

Project AIMS Publications

GRADES 5-8 SERIES

Math + Science, A Solution
The Sky's the Limit
From Head to Toe
Fun With Foods
Floaters and Sinkers
Down to Earth
Our Wonderful World
Pieces and Patterns, A Patchwork in Math and Science

GRADES K-4 SERIES

Fall Into Math and Science
Glide Into Winter With Math and Science
Spring Into Math and Science
Seasoning Math and Science, Book A (Fall and Winter)
Seasoning Math and Science, Book B (Spring and Summer)
Jawbreakers and Heartthumpers
Hardhatting in a Geo-World
Popping With Power
Overhead and Underfoot

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The conditions and restrictions are as follows:

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2. Where school districts wish to use the program districtwide and duplicate the materials in the central office, reproduction rights for making more than 200 copies may be purchased from the Foundation. For information, contact the Foundation office.

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   b. Each page or collection of pages must have the statement "Used with the permission of the AIMS Education Foundation, P.O. Box 7766, Fresno, California 93747. Reproduction rights to these copies of the original is limited to 30 copies for classroom testing only."

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TOPPLE THE TUBE

I. Topic Area
Physical Science — Paper Tubes

II. Introductory Statement
Students will become familiar with strengths of paper tubes.

III. Math Skills
Measuring
Estimating
Counting

Science Processes
Observing
Controlling Variables
Recording Data
Hypothesizing
Applying & Generalizing

IV. Materials
sheets of 8½ X 11 inch ditto paper
centimeter ruler (optional)
cellophane tape
hardback textbooks of uniform size and weight
worksheet

V. Key Question
Can you make a paper tube that is strong enough to support the weight of several books?

VI. Background Information
1. The thicker the walls of a tube, the more weight it will support. The shorter the tube, the greater the supporting power.
2. Teacher made demonstration tubes should have similar diameters but different heights.
3. Books used as weights need to be hardback and of uniform size and weight, such as all language or math texts.
4. Tubes are found in nature and are used by man both in the vertical and horizontal positions. Tubes are used underground to carry many utilities and gas, and must bear the weight placed on top by buildings and vehicles. Tubes are found vertically supporting buildings, freeways, bridges, and some homes. Tubes are used singularly or bundled as girders, on bridges, roofs, and buildings.

VII. Management
1. Class period of 45 to 60 minutes, or two days of 30 to 40 minute periods each.
2. Make two paper tubes of different height prior to the investigation and have books ready for demonstration.
3. As an explanation of what students should expect, the teacher will demonstrate the strength of varying height tubes.
4. Students may work in groups of 4 to 6 or individually.
5. Students will need several sheets of ditto paper and several pieces of cellophane tape for their tube construction.
6. Books used for weights need to be hardback and of uniform size and weight, such as all language or math or science texts.
7. Worksheets need to be prepared in advance.
8. A transparency of the worksheet may be made to be used on an overhead projector as a guide.

VIII. Procedure
1. Teacher will use different tubes of similar diameter and different heights. Stand tubes on end and use the books as weights until tube collapses or breaks down. (Watch for true tube breakdown and not just book-weight imbalance).
2. Students will record estimates and actual counted number of books it took for the demonstration tubes to collapse on their worksheets, diagram A.
3. Students will construct and test a tube of their own design, estimate the number of books it will hold, test and count the actual number of books supported and record data on their worksheets, diagram B.
4. Students will analyze and make generalizations about their tube design and results.
5. Students will reconstruct another tube, estimate, test, and record this test data on the worksheet, diagram C.

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IX. What the Students Will Do

1. Students will estimate and record the number of book-weights teacher demonstrated tubes will support.
2. Students will discuss reasons for variations in the tubes' strengths.
3. Students will use a piece of ditto paper and small pieces of tape to construct their own paper tube.
4. Students will estimate and test their tube's strength using the hardback books.
5. Students will count and record the number of books their tube supported and record data.
6. Students will analyze and make generalizations about their test results.
7. Students will redesign, construct, estimate, and test another paper tube and record data.
8. Students will write sentences about changes made in their tube design and construction and the resulting strength.

X. Discussion

1. How much weight will a tube support?
2. Does the diameter and/or thickness of the tube walls affect the amount of weight it will support?
3. Does the height of a tube affect its supporting power?
4. How are tubes used in nature for support?
5. How are tubes used in construction?

XI. Extension

1. Use rolled and glued sheets of newspaper to make a structure strong enough to support your weight.
2. Experiment with tubes of varying diameters and keep the height and wall thickness constant.
3. Use a given amount of straws and tape to construct the tallest possible self-standing structure.
4. Investigate and find pictures showing how tubes are used in building and construction.
5. Investigate how bundling tubes affects the supporting power.
6. Find out about different materials and methods used in construction to reinforce materials and increase tube strength.
7. Walk around your school and find examples of tubes used as supports.
8. Study how tubes are used horizontally in construction.
9. How are tubes joined together in construction?
10. Study architectural structures to see how tubes are used and decorated.
11. Use toilet paper tubes, paper towel tubes, and try other materials to make tubes and test their strength.
12. Weigh the books used and calculate the total weight each tube supported.

XII. Curriculum Coordinates

1. Creative Writing — Write a story about "My Life As a Paper Tube".
2. Science — Investigate plants with and without tubes, and different bone structure and composition of some birds and animals.
3. Art — Create a cartoon about the "Adventures of Toobie Tube".

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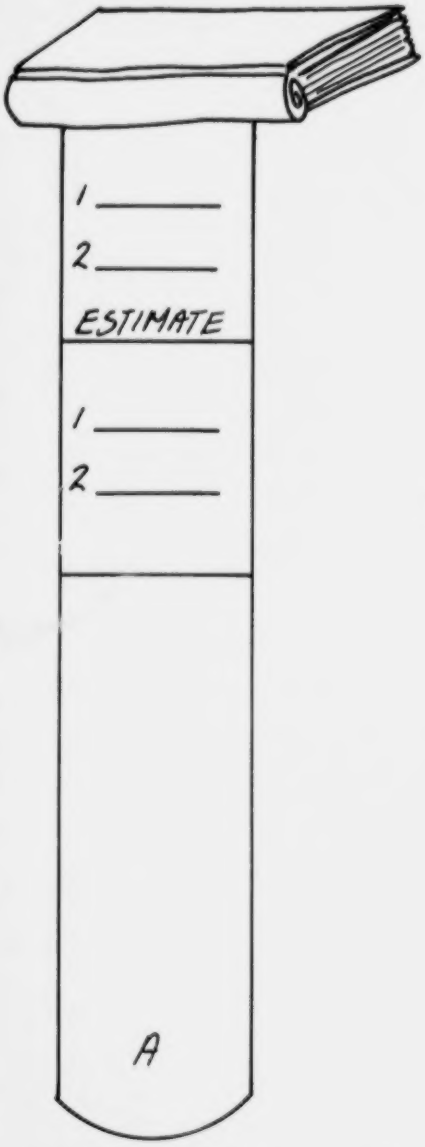
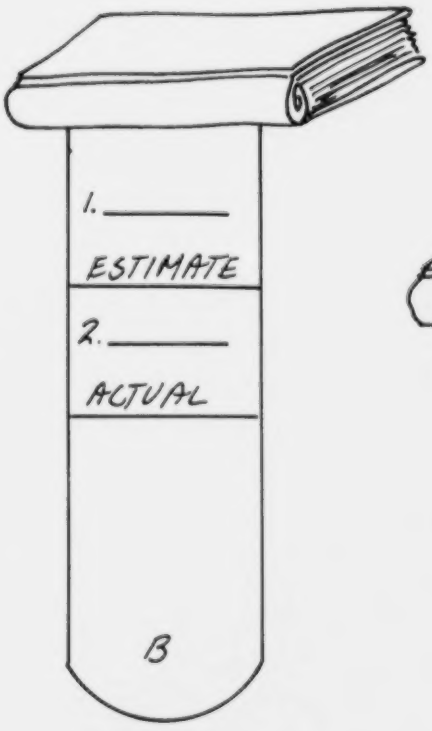
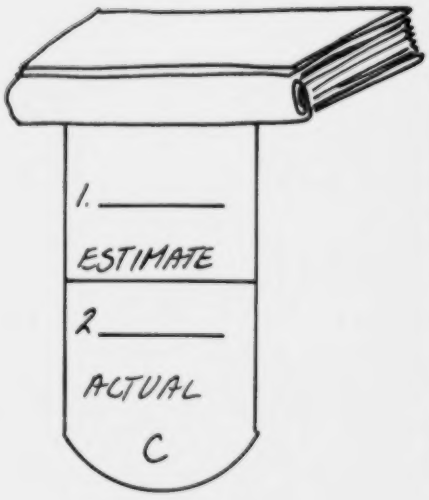
NAME _____

TOPPLE THE TUBE







1. ESTIMATE THE NUMBER OF BOOKS YOUR TUBE WILL SUPPORT. _____

2. HOW MANY BOOKS DID YOUR TUBE SUPPORT? _____

3. USE A NEW PIECE OF PAPER TO REDESIGN AND CONSTRUCT A STRONGER TUBE. HOW MANY BOOKS DID THIS TUBE SUPPORT? _____

4. ON THE BACK OF THE PAPER TELL WHAT CHANGES YOU'VE MADE IN YOUR TUBE AND HOW IT CHANGED THE RESULTS.

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IT'S ALL IN THE JOINTS

I. Topic Area

Physical Science — Strength of joint types

II. Introductory Statement

Students will discover the strength of various structural joint types.

III. Math Skills

Estimating
Measuring
Geometry

Science Processes

Observing
Controlling Variables
Gathering & Recording Data
Hypothesizing
Generalizing

IV. Materials

plastic drinking straws
Tacky glue
pipe cleaners (rough type)
plasticine or clay
straight pins
tape
spring scale
record sheet

V. Key Question

What is the best way to join tubes together for the greatest strength?

VI. Background Information

Tubal materials can be seen joined together both in nature and in construction. Observe how these various materials are joined together. Metal materials are often joined together using welds, screws, epoxy materials, threads, etc. Wooden materials often use bolts, nails, screws to join materials. In our human body special joint types and "hinges" are found. As you do this experiment, watch carefully to see in which cases the joint fails, or in which cases the walls of the materials fail. The triangle shape is the strongest geometric shape. How the sides are joined together also effects the strength.

VII. Management

1. Class period of 30 to 45 minutes.
2. Straws used need to be plastic and of the same diameter and length.
3. Glue needs to be quick drying and type used for plastics and crafts, suggested is Tacky Glue.
4. Pipe cleaners used need to be the very rough type, several wound together, so they'll adhere to the walls of the straws.
5. Teacher will need to construct in advance one of each of the four joint types in their triangular form for each group.
6. A spring scale will be needed for each group to measure the stress or strength for each joint type.
7. Students will work in groups of 4 or 5, or the activity may be done as a total class lesson.
8. Each structure type will need to be taped securely to a table for support.
9. Stress or pull on the scale will need to be applied slowly and at least 2 students will need to be observers of the scale reading. The scale will very quickly return to zero after reaching the maximum stress level and the structure fails.

VIII. Procedure

1. Teacher will make sufficient models of each joint type prior to the investigation, enough for each group.
2. Teacher will model each joint structure and discuss the method of construction. DO NOT TEST WITH SCALES.
3. Teacher will discuss with the class certain variables needing control prior to testing, such as where to hold the structure, placement of and the reading of the scales, and how to apply the stress slowly.
4. Students will work in groups of 4 or 5, or as a total class group.

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IX. What Students Will Do

1. Students will examine the teacher made models and listen to teacher input about the various joint types and their construction.
2. Students will predict which joint type will be the strongest and record it on their worksheet.
3. Students will estimate the force in amount of grams each joint type will hold and record on their worksheets.
4. The pull or stress on the scales must be applied slowly and several students used as observers to read the scales quickly.
5. Test results will be recorded on worksheet for each type of joint.
6. Students will compare their test results with their estimates, discuss, and make generalizations.

X. Discussion

1. Which joint type did you predict would be the strongest?
2. Which joint type actually was the strongest? Why?
3. What problems or weaknesses did you observe in each of the joint types?
4. Did all of the joint types fail first, or were there structural failures in any models prior to the joint failure?
5. Can you think of ways these joint types can be made stronger?

(You will find that the glue and clay joints are weakest. The pipe cleaner joint is fairly strong. The strongest joint appears to be the pin joint, with structural failure often coming before joint failure in this model.)

XI. Extensions

1. Look aroud your classroom or school to see how materials are joined together.
2. Find out how materials are joined together in the construction of buildings, bridges, freeways, etc.
3. Find out how our body bones and parts are joined together.
4. Find out how engineers use pin-joints.
5. Read about civil engineering, or invite an engineer to come talk to your class.
6. How does nature use joint types? Observe plants and animals.

XII. Curriculum Coordinates

1. Use straws and joints to build a dome or bridge structure.
2. Make a mobile using different joint types.
3. Learn the song "Dem Bones".

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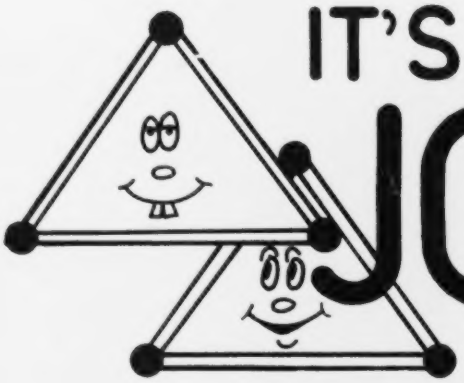

IT'S ALL IN THE JOINTS

PREDICT WHICH JOINT TYPE WILL BE STRONGEST.

JOINT	ESTIMATE FORCE IN GRAMS	ACTUAL FORCE IN GRAMS
GLUE		
PIPE CLEANER		
CLAY		
PIN		

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I. Topic Area
Structure

II. Introductory Statement
Students will learn how to construct a tall stable structure.

III. Math Skills
Estimating
Measurement: Metric
Whole Number Computation
Averaging
Graphing

Science Processes
Measuring
Gathering & Recording Data

IV. Materials
Per group: 20-50 plastic straws
straight pins
clay (for anchoring bottom of structure to floor ONLY)
metric measuring tape

V. Key Question
How high can you build a structure using straws and pins?

VI. Background Information
"The job of a skeleton frame is to carry a skyscraper's weight. This weight is referred to as the load. The load includes the actual weight of the building: its foundation frame, floors, roof, walls, and all the trims and furnishings that are likely to be brought into the building.

"The movement of air around all buildings is also taken into consideration in measuring loads. Enormous building surfaces are exposed to continually changing air movement. At great heights the speed of air increases, and the force of such winds adds much weight to the overall load of the building.

"Just as wind sways a tree, strong winds at great heights can cause unsafe movement in a skyscraper. For this reason, a skyscraper's frame must be strong and rigid. To make a frame stiff enough to withstand wind pressure, bracing is sometimes used on the outside surfaces of the building."

from SKYSCRAPERS: A PROJECT BOOK
by Anne and Scott MacGregor

VII. Management
1. This activity will take 1 - 1½ hours.
2. Teacher needs to determine number of straws that is appropriate for grade level.

VIII. Procedure
1. Divide the class into groups of 2 or 3.
2. The teacher will provide each group with straws, pins, and enough clay to anchor each structure. If working on carpet, you do not need clay.
3. Construction should take place on the floor.
4. Set a time limit of 45-60 minutes for actual construction.
5. Stress that the structures must be self-standing to be measured.

IX. What the Student Will Do
1. The students will construct a tall structure that is free-standing.
2. Students will measure the heights of their structures.
3. Students will record and graph their data, and complete the worksheet.

X. Discussion
1. What factor is the most important in determining how high a structure can be built? (You need a firmly braced foundation.)
2. Discuss the idea of 'strength versus height'.

XI. Extension
1. Subject the structures to 'earthquake' activity. Observe what happens.

XII. Curriculum Coordinates
Language
1. Pretend that you live on the top floor of a skyscraper. Describe the good and bad points.
2. See the movie "King Kong".

Art
1. Make tall buildings out of natural objects such as twigs, etc.
2. Construct a science fiction city.

Science Studies
1. Compare life in a big metropolis (New York, San Francisco, Chicago) to life in a small country town, to life in a third-world town, in terms of buildings.
2. Research the many different buildings in the world.
3. Make models of different architectural styles.
4. Research and do reports on the Great Pyramids, Stonehenge, and other unusual buildings.

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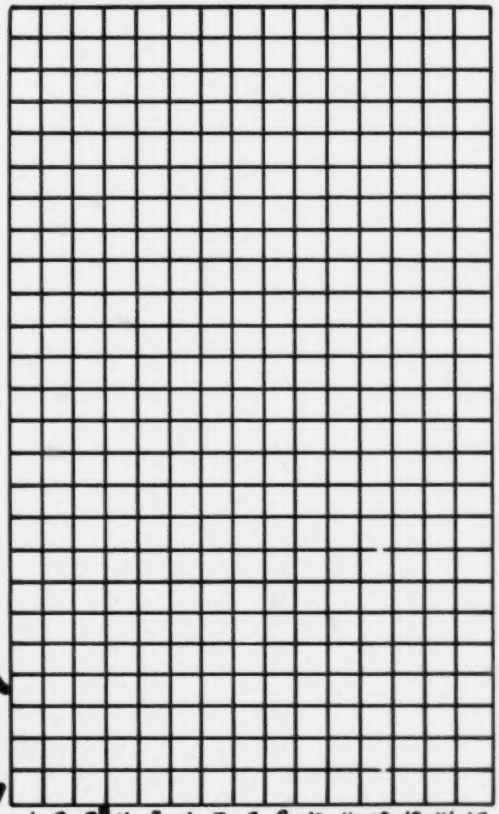
SKY HIGH

HOW HIGH CAN YOU BUILD A STRUCTURE USING 50 STRAWS AND PINS?



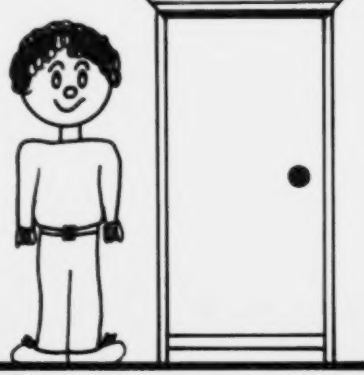
	ESTIMATE	ACTUAL
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
TOTAL		
AVERAGE		

TEAM MEMBERS

_____

_____

_____



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TEST MY STRESS

I. Topic Area

Physical Science — Strength of paper structures

II. Introductory Statement

Students will discover the relationship between strength and shape.

III.

Math Skills	Science Processes
Counting	Observing
Estimating	Generalizing
Measuring	Gathering & Recording Data
Ordering	Hypothesizing
Geometry	Controlling Variables

IV. Materials

8" X 10" ditto or thin paper
gram to kilogram weights
2 identical books (end supports for structures A and C)
tape
ditto masters for structure shapes and "car"
centimeter ruler (optional)
graph paper (optional)

V. Key Question

How much weight can a bridge support before it collapses?

VI. Background

It is important to know the law of force: Forces come in pairs; where there are forces there are always others of equal amounts in the opposite direction to balance, as long as nothing moves.

What is usually needed is the strongest structure with the least amount of materials.

You may measure the amount of weights it takes before the "bridge" collapses and loses its shape, or you may measure the amount of sag and graph the differences.

Vocabulary which may be helpful:
rigid — won't bend
flexible — samples bend and spring back
abutments — the support at the end of a bridge
load — weight
compression — pushing forces either downward or from the side
tension — pulling the ends apart
buckling — crosswise bend
sag — to bend downward

VII. Management

1. Class period of 60 minutes, or two periods of 30 minutes each.
2. In structure A, structure will be suspended between two identical supports.
3. Other structures B-F will be supported at ends as shown on worksheet.
4. Weights must be placed on the center of the paper structures and not at the sides or near the ends. Class discussion needs to be held and decisions made concerning (a) car placement and direction on each structure, (b) how weights are placed in car, and (c) how to determine bridge structure collapse.
5. Students may be divided into work groups of 5 or 6, or the investigation may be performed as a total class.
6. Structural models may be made in advance by the teacher for each group; or students, under the careful guidance of the teacher, may construct their own models. If the students make their own models, allow two days for the complete investigation.
7. If gram weights are not available, paper clips, marbles, or some standard sized item may be used and then weighed to calculate gram amounts.
8. It is helpful to have another adult present to assist during the investigation.
9. For advanced groups you may measure sag using a centimeter ruler if desired, and graph weight versus sag.

VIII. Procedure

1. Have various paper structural models made in advance, or guide students in construction of models A-F.
2. Have 2 identical books for end supports.
3. Have many gram to kilogram weights available.
4. Have paper "car" made to hold weights for each group (see master).
5. Divide students into work groups of 5 or 6.
6. Discuss importance of placement of weights in "car" and the location of weights on center of structure rather than near the end supports.

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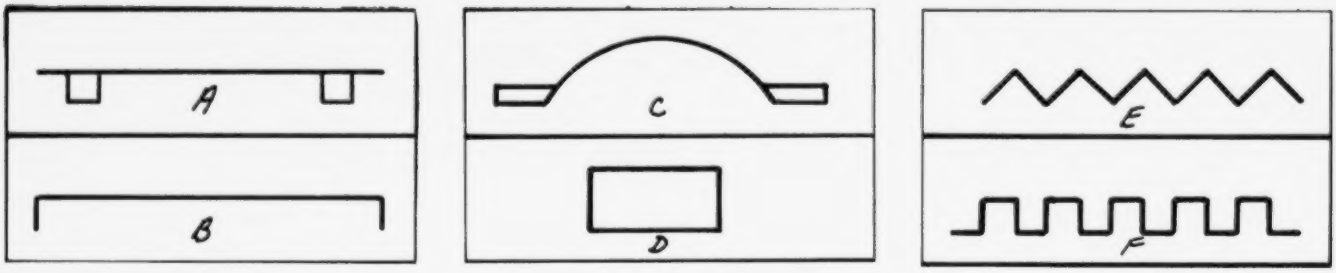

7. Students will predict sequence of structures A-F according to strength (strongest to weakest) and record on worksheet.
8. Teacher will monitor groups during investigation.
9. Teacher will follow up investigation with guided discussion.

IX. What Students Will Do

1. Students will observe various structural models made by teacher and discuss construction of each.
2. Students will predict order of structures and their support capabilities (strongest to weakest) and record on worksheet.
3. Students will estimate the amount of weight in grams each structure will support and record on worksheet.
4. Students will work in groups of 5 or 6 to test the six structural models for amount of weight support.
5. Students will test structures and record actual amounts of weights for each shape.
6. Students will compare their estimate and actual weights.
7. Students will discuss results and form conclusions.
8. Students will write about their findings.

X. Discussion

1. How much weight did a flat structure support (A)?
2. What change in weight support was made when the edges of paper are turned down (B)?
3. How much weight support was there with the arch (C)?
4. What was the effect when the paper was folded like a box (D)?
5. What change in support occurs when you tried the two folded shapes (E and F)?
6. What shape seemed to be the strongest? Weakest? Why?
7. How could you make a stronger structure?

XI. Extension

1. Use cards or paper, glued on the sides of the folded paper structures E and F and test their strength.
2. Use corrugated cardboard and test the strength.
3. How will you design a stronger structure? Can you combine shapes and structures? Try to make one and test.
4. Use a centimeter ruler to measure sag and graph the results.
5. Use straws, balsa wood and construct bridges to test.
6. Read about different types of bridges and terms (plank, trusses, girders, lattice, cantilever, suspension).
7. Find examples in nature of similar support structures.
8. Explore research books about how the human and animal bodies are structures for support.
9. Find examples in construction of support structures.
10. What is symmetry and how does it effect support?
11. Read about geodesic, and use straws to form a geodesic dome.
12. Contact the State Highway Dept. or a mechanical engineering firm to visit your class and discuss construction.

XII. Curriculum Coordinates

Art — paper and straw construction to form models or three-dimensional art.

Social Studies — career opportunities.

Suggested reference books for students/teachers:

Goldwater, Harvey, BRIDGES AND HOW THEY ARE BUILT, William R. Scott, Inc. 1965.

MacGregor, Anne and Scott, BRIDGES, A PROJECT BOOK, Lothrop, Lee & Shepherd Books, New York, 1980.

Peet, Creighton, THE FIRST BOOK OF BRIDGES, Franklin Watts, Inc., New York, 1953.

Wells, Robert, WHAT DOES A CIVIL ENGINEER DO?, Dodd, Mead & Company, New York, 1960.

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NAME _____

TEST MY STRESS

SHAPE OF STRUCTURE	PREDICTED ORDER	ESTIMATED WEIGHT (GM)	ACTUAL WEIGHT (GM)
A			
B			
C			
D			
E			
F			

DESCRIBE THE STRONGEST AND WEAKEST STRUCTURES.

TELL HOW THE STRUCTURES ARE ALIKE AND HOW THEY ARE DIFFERENT.

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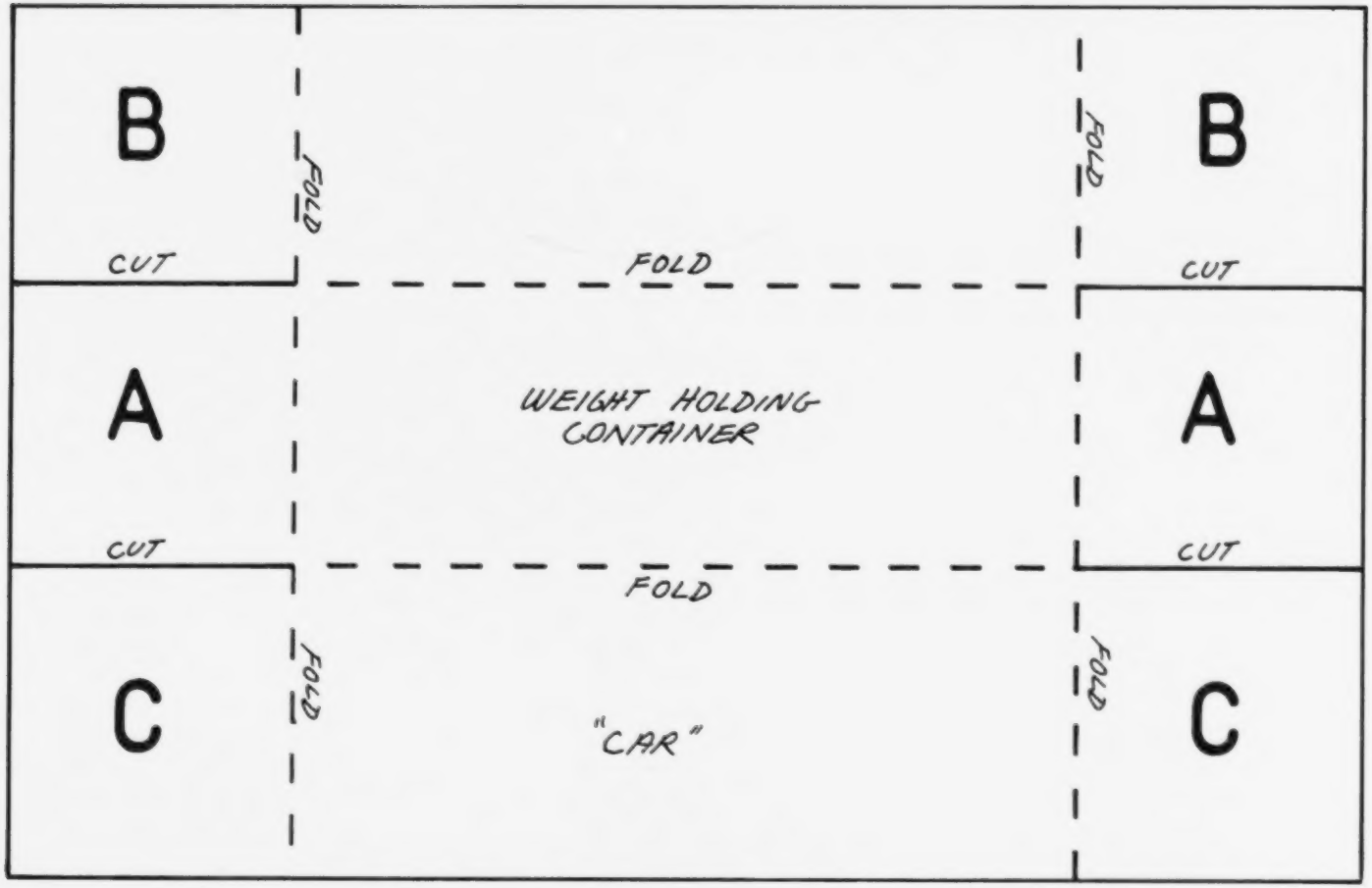

FOLD B AND C BEHIND TAB A. FOLD TWO LONG SIDES UPWARD. TAPE

A STRUCTURE

CUT

FOLD

B STRUCTURE

24

25

FOLD

HARDHATTING IN A GEO-WORLD

13.

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C STRUCTURE

CUT

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FOLD

D STRUCTURE

FOLD

FOLD

TAPE EDGES

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28

FOLD

FOLD

FOLD

SUSPENSION POWER

I. Topic Area

Physical Science — Physical forces and suspension bridges.

II. Introductory Statement

Students will observe the various forces in use with supporting weight on a suspension bridge.

III.

Math Skills	**Science Processes**
Estimating	Observing
Measuring	Recording Data
Counting	Generalizing
Geometry	Hypothesizing
	Controlling Variables

IV. Materials

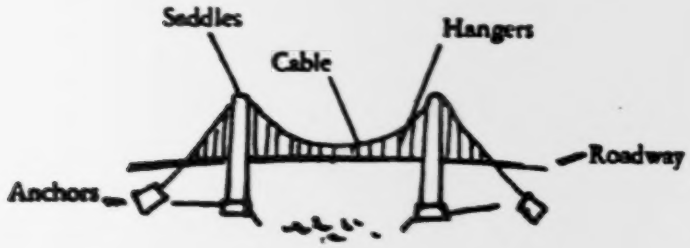
cotton kite string
small paper or foam cup
1 piece of pine board about 12" X 36" X 1"
2 large, equal sized books, at least 10" X 8" X 2"
metric weights from grams to kilograms
2 thumb or carpet tacks

V. Key Question

What makes a suspension bridge strong and able to support weight?

VI. Background Information

1. Forces always come in pairs: for every action there is an equal and opposite reaction (Newton's 3rd law of motion).
2. Forces in a suspension bridge: tension force of the cable to hold up the road; push of the tower to hold up the cable; push of the lower end of tower on the earth; push of the earth against the foot of the tower.
3. There are three main supporting parts of any suspension bridge: cables, towers, anchorages (support).



Towers are made of wood, stone, and steel. Their height depends on the amount of sag or curve required for the cables.

Anchorages hold the ends of the cables and must be strong. The cables are the most important part of the bridge, as they support the roadway and give the bridge its shape and beauty. Early suspension bridges used cables made of vines and split bamboo woven into ropes. Modern suspension cables are often made of steel wire.

4. Vocabulary:
   anchors — natural solid bedrock or massive reinforced concrete to which cables are fastened.
   hangers - vertical cables connecting the cable and the roadway.
   saddles - large roller-like pulleys over which the cable passes.
   tension - forces pulling ends apart.
   compression - pushing forces either downward or from the sides.
5. Suspension bridges are tension structures, very strong and making the most efficient use of materials. In addition they are aesthetically pleasing and often quite delicate and graceful in appearance. Suspension bridges are capable of spanning great distances. An advantage is that years after their construction additional decks may be added to handle increasing amounts of traffic. Modern suspension bridge construction may use box girders to replace traditional trusses adding greater strength and stability to the bridge decking.
6. Students will discover the stress and collapse of bridge 1 without anchor supports, when there is increased stress or weight on the cable. Students need to be guided to see the geometric shape of the two triangles formed by both side anchors and the towers on bridge 2. The triangle is the strongest geometric shape. This increased strength created by side supports and anchors can be clearly seen with bridge 2.
7. Students may be interested in knowing the spans of some famous bridges. Relating the lengths of the spans to your playground area might provide an effective visual.

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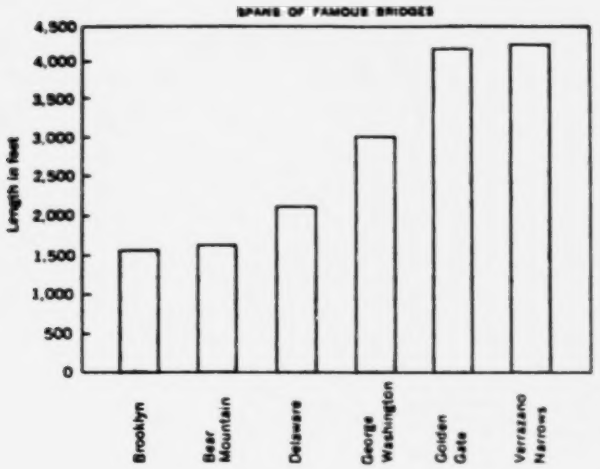


VII. Management

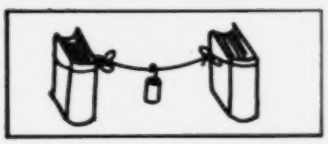
1. Class period of 30 to 45 minutes.
2. Either done as a total group or small group (4 - 6) investigation under the direction of the teacher.
3. Some pictures of actual suspension bridges should be available to introduce the topic.

VIII. Procedures

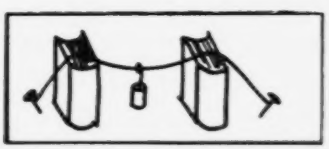
1. Teacher will show students some pictures of actual suspension bridges.
2. It is important that the books used for towers be of identical size and shape approximately 8" X 10" X 2".
3. Teacher will tie string around the two book towers near the top for the first part of the investigation. Books should be standing on end, about one foot apart, and about one foot of string sagging between.
4. Teacher will assist students in attaching the suspended cup to hold weights. Cup should be attached in the center of the string.
5. Teacher will have available a large amount and variety of weights from gram to kilogram. Non-standard weights such as paperclips or marbles may be used if gram weights are not available.
6. Teacher will assemble cable, tacks, and book towers for the second part of the investigation.
7. Teacher will lead discussion during and after investigation.

IX. What Students Will Do

1. With teacher's assistance, tie a two foot long string around the tops of two book towers standing on end, about one foot apart, leaving about one foot of string to sag between.
2. Students will tell what they think will happen when weight is applied to this structure. They will record their prediction on chart.
3. Students will slowly place weights in the suspended cup hanging from the center of the string-cable.
4. Students will observe what happens, count the amount of weight supported before the book towers collapse, and record results on their worksheet.



5. Students, with the teacher's assistance, will set up the second bridge as pictured below, using the same amount of string, same two book towers, and two thumb tacks. (Pass the string from the board, fastening the string to the board at each end with thumbtacks).
6. Students will predict the amount of weight this bridge construction will support and record on their worksheets.
7. Students will slowly place weights in the suspended cup and observe what happens to the cable, tacks, and towers.
8. Students will count the weight supported and record on their worksheets.
9. Results will be compared, generalizations made, and a few sentences written on worksheet for each bridge type.



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X. Discussion

1. What happened when weight was applied to the book-tower bridge 1, with just the string tied around the towers?
2. Where did this bridge break down, why?
3. When tacks were fastened and string attached to them in bridge 2, what geometric shape was formed by the book, string, and tack at each end of the bridge?
4. What was the change in amount of weight this bridge supported?
5. Where did the second bridge fail?
6. How do you think the bridge could be made stronger?

XI. Extensions

1. Use wooden gate playground poles and rope to try constructing and testing a wider-spanned bridge.

2. Place bathroom scales under each pole (tower) to measure the downward force, or place a spring scale at various places in the cable to check the amount of force on the rope cable.
3. Change the angles of the anchors and towers so they are not equal at both ends and observe what happens when weight is applied to the center of the cable.
4. Build a model suspension bridge, use an electric fan and toy car to observe the effect of winds on bridges.
5. Add trusses made from some light material to your model bridge in #4 and observe what happens when the fan wind now hits the bridge.
6. Read about early and modern suspension bridges.
7. Read about aerodynamics and how engineers are solving suspension bridge problems today.
8. Make a rope suspension bridge.
9. Invite a civil or mechanical engineer to your classroom to discuss how bridges and buildings are made strong, and modern construction techniques.

XII. Curriculum Coordinates

Language arts — find names of famous suspension bridges in the world, make a scrapbook.

Art — draw a bridge or construct one of your own design.

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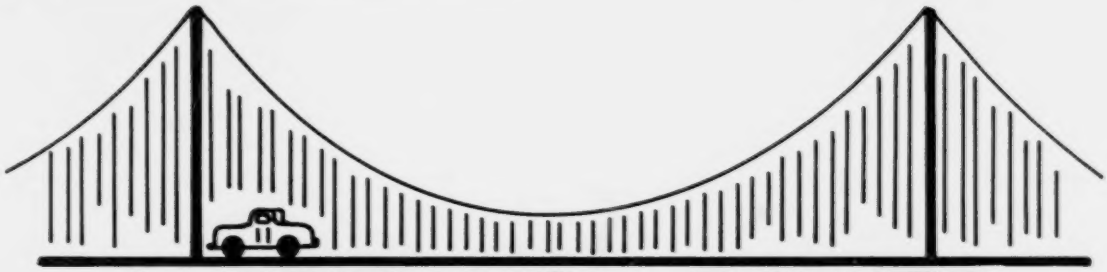

SUSPENSION POWER

TELL WHAT YOU THINK WILL HAPPEN WHEN WEIGHT IS PUT ON THE STRING CABLE OF THIS BRIDGE.

RECORD YOUR DATA FOR BRIDGE 1 BELOW:

BRIDGE 1	PREDICTION	ACTUAL
	_____ G	_____ G

WRITE A SENTENCE OR TWO BELOW TELLING WHAT HAPPENED TO THIS BRIDGE WHEN WEIGHT WAS APPLIED:

_____

_____

_____

TELL WHAT YOU THINK WILL HAPPEN NOW WHEN WEIGHT IS PUT ON THE STRING CABLE OF THIS BRIDGE.

RECORD YOUR DATA FOR BRIDGE 2 BELOW:

BRIDGE 2	PREDICTION	ACTUAL
	_____ G	_____ G

WRITE SEVERAL SENTENCES ABOUT BRIDGE 2 AND TELL WHAT HAPPENED WHEN WEIGHT WAS APPLIED:

_____

_____

_____

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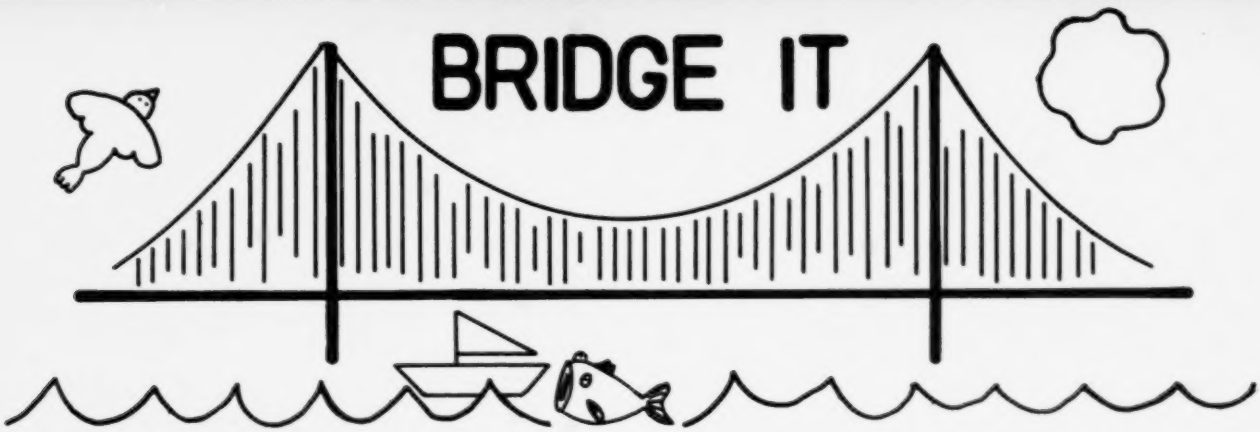
BRIDGE IT



I. Topic Area
Structure

II. Introductory Statement
Students will learn to construct a bridge that will support weight.

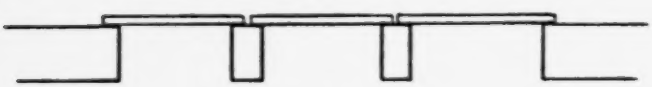
III. Math Skills
Estimating
Whole Number Computation

Science Processes
Predicting
Gathering & Recording Data
Interpreting Data

IV. Materials
plastic straws
straight pins
masking tape
metal washers (any size)
large paper clips

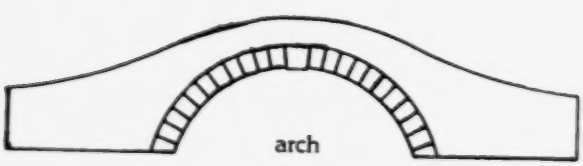
V. Key Question
How strong can you build a bridge?

VI. Background Information
1. There are three basic types of bridges: beam, suspension, and arch.



beam

suspension



arch

2. Changes in the appearance of bridges are the result of different materials.
3. An arch bridge, the Sydney Harbor Bridge, holds the world record for the heaviest load.

VII. Management
This activity will take 1-1½ hours.

VIII. Procedure
1. Teacher will introduce students to the three types of bridges.
2. Teacher will provide materials to each group of students.
3. Class will be divided into groups of 2-3 students.
4. Distance between desks will be determined by how much time is to be allotted.
5. There is no limit on number of straws and straight pins per group.
6. Set a time limit for actual construction of bridges (45-60 minutes).
7. Masking tape is only used to anchor bridges to desks.

IX. What the Student Will Do
1. Students will construct a desk-to-desk bridge.
2. Students will estimate the number of washers their bridge will hold and record data.
3. Students will hang washers on their bridges and record the actual number it takes to break the bridge.
4. Students will interpret and predict data using class and individual data.

X. Discussion
Refer to student worksheet.

XI. Extensions
1. Build bridges on tabletops. Investigate how much weight they can carry.
2. Do investigation "Topple the Tube".

XII. Curriculum Coordinates
1. Music — Learn the song "London Bridge Is Falling Down".
2. P.E. — Play "London Bridge Is Falling Down". Build kid bridges. Go over and under in various ways.
3. History — Research famous bridges and prepare a report. See the movie "Bridge Over The River Kwai".
4. Art — Build bridges out of different materials.

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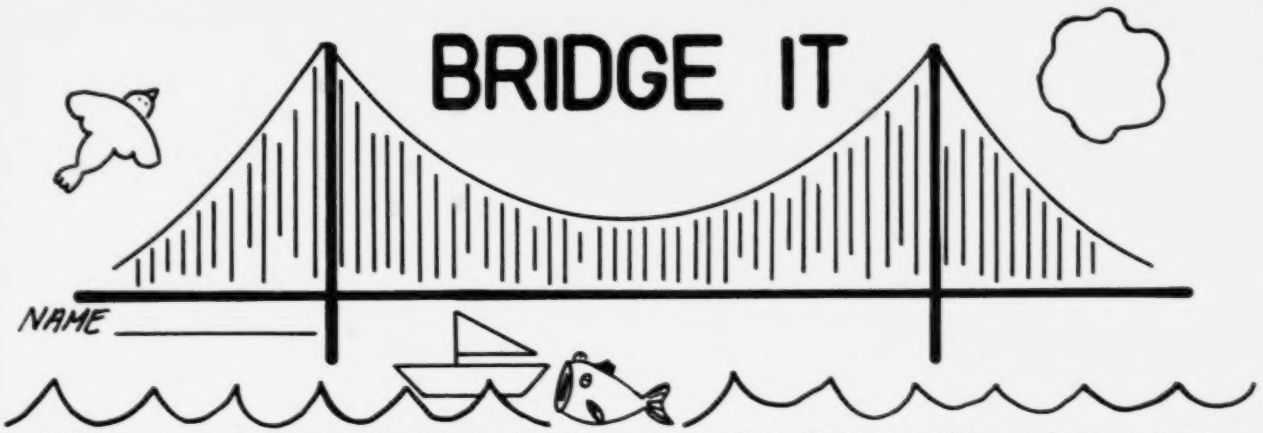
BRIDGE IT



NAME _____

WHAT IS THE STRONGEST BRIDGE YOU CAN BUILD FROM STRAWS AND PINS?

BRIDGE NAME	# WASHERS ESTIMATE	# WASHERS ACTUAL
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

ESTIMATES!

1. WILL YOUR BRIDGE COLLAPSE QUICKER WITH THE WASHERS ALL IN ONE PLACE OR SPREAD OUT?

_____

2. CAN YOU PREDICT AT WHICH POINT YOUR BRIDGE WILL WEAKEN FIRST?

_____

AFTER COLLAPSE!

1. HOW COULD YOU HAVE MADE YOUR BRIDGE STRONGER?

_____

_____

_____

_____

_____

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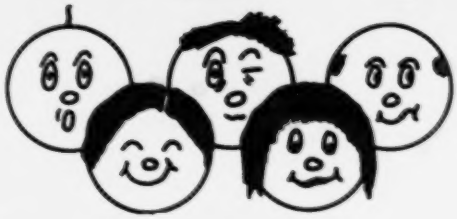
SPACE OLYMPICS



I. Topic Area
Space Olympics

II. Introductory Statement
The students will notice the effects of varying gravity of different planets on athletic results.

III. Math Skills
Averaging
Addition
Multiplication

Science Processes
Observing
Measuring
Recording Data
Applying & Generalizing

IV. Materials
paper
ink pads
books
Nerf Balls
pencil
Student Worksheets
masking tape

V. Key Question
Where should the Olympics be held in 2024?

VI. Background Information
Gravity is the force by which all matter tends to be drawn to all other matter. The larger the mass, the stronger the gravitational pull.

Consequently, for example, a person will be able to jump six times as high on the moon as on the earth, since the gravitational force is only 1/6 of that on the earth.

For this experiment, these factors for distance in relation to the earth are given to the nearest whole number.

EARTH 1 MOON 6 MARS 3

To determine the students' performance on the moon or Mars, multiply the Earth distance or weight lifted by the given factors. (The figures are on the student worksheet.)

VII. Management
1. Students are divided into groups of 5 maximum.
2. Each student is entered into one or more events.
3. One event is held at a time.
4. Other team members are seated as "Intergalactic Spectators".
5. Competing team members from all teams, for a given event, will complete three trials (all students complete trial 1 before second trials begin).
6. Use either Metric or American measurements, which ever is easiest.
7. Students then average their three trials. Using this average, the students then find their performance by multiplying the average by the gravity on the three space places.

VIII. Procedure

SKY HIGH (JUMPING)
1. Using butcher paper, calibrate the paper from three to eight feet by inches. Tape the paper to a wall or basketball pole.
2. Using the ink pad have the competitor ink his index finger.
3. Have him reach up the paper and touch as high as possible. This is the "base" to make your measurements from.
4. Have the student jump and mark as high as he can.
5. Write his initials by the mark.
6. Measure the distance from the "base" mark to the jumped mark.
7. Repeat steps 4-6 for the last two trials.
8. Enter information on the worksheet.

SHOOTING STAR (DISTANCE THROW)
1. Using masking tape, mark off starting line.
2. Students throw Nerf Ball as far as possible.
3. Measure distances for trials 1, 2, and 3.
4. Enter information on worksheet.

ASTEROID BELT (DISTANCE KICK)
Procedure same as Sky High except the ball is placed on the floor and kicked.

SHUTTLE SCUTTLE (STANDING LONGJUMP)
1. Using masking tape, mark off starting line.
2. Jump from standing position as far as possible.
3. Measure closest position to starting line. I.E. if they fall backwards, you measure the place where their hand lands.
4. Enter information on worksheet.

LUNAR LIFT (ONE—HANDED BOOK LIFTING)
1. Student chooses either right or left hand.
2. Books of identical type are placed on the students hand. Dictionaries or history books work well.
3. Make sure the student has his arm outstretched. There should be no bend in his elbow.
4. Place the books on his hand until he bends his arm or the books fall off.
5. Count the number of books placed on the hand just before they fall. Don't count the last book.
6. Enter the number of books held on the worksheet.

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IX. What the Students Will Do

1. The students will record their scores in the correct places on their charts.
2. Worksheet 1 is to be completed by the individual student.
3. Worksheet 2 is to be completed by teams.
4. The student will share with his team members his score for his events.
5. The student will record the other team member's scores on his worksheet in the correct places.
6. All team members will calculate the Grand Total for their team.
7. The team with the highest Grand Total is the winner.

X. Discussion

1. Where would you like the Space Olympics to be held?
2. On which planet would you do the best? (Moon)
3. Why is the gravity on the Moon so low compared to Earth? (The mass of the Moon is less than the Earth.)

XI. Extension

1. Make a bar graph comparing the different events on each planet.
2. Find out which team won the most gold, silver, and bronze medals for each event.
3. Calculate the results for the planet Pluto. It has a factor of 25.

XII. Curriculum Coordinates

LANGUAGE ARTS

Write a paragraph describing your event and your results.

P.E.

1. Do warm-up exercises for your event.
2. Move in slow motion as if you were doing your event in a confining space suit.

ART

Draw a picture of you doing your event on two different planets and show in the pictures how the results differ.

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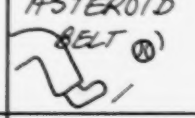
SPACE OLYMPICS
TEAM RECORD SHEET

EVENT _____ NAME _____

	ASTEROID BELT 	SHUTTLE SCUTTLE	SHOOTING STAR	LUNAR LIFT	SKY HIGH
EARTH					
MARS					
MOON					
TOTAL FOR EACH EVENT	1	2	3	4	5

TO FIND YOUR TEAM'S GRAND TOTAL, ADD THE SCORES TO BOXES 1-5.

1 _____
2 _____
3 _____
4 _____
5 _____
GRAND TOTAL _____

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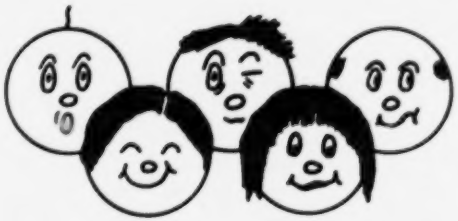
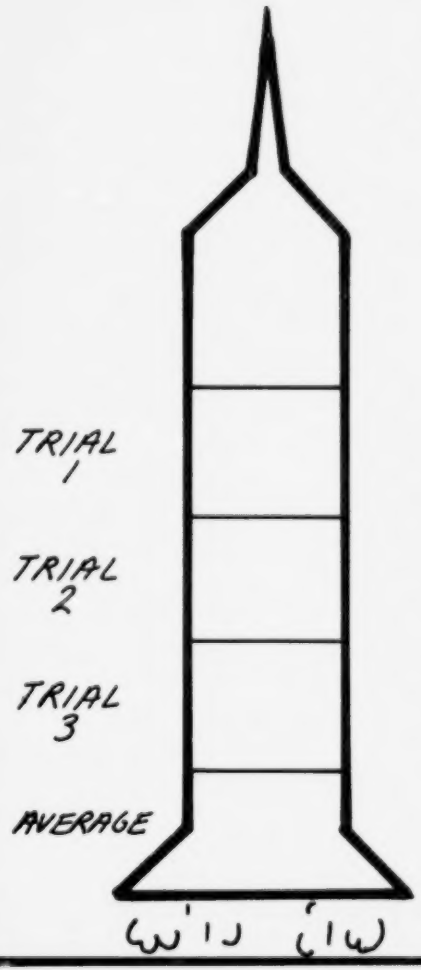
SPACE OLYMPICS

NAME _____ EVENT _____ TEAM _____



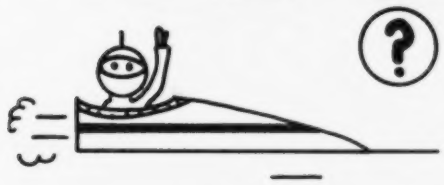


PLANETARY RESULTS

	DISTANCE TIMES THAT ON EARTH		YOUR AVERAGE		RESULTS FOR PLANET
EARTH	1	x	_____	=	_____
MARS	3	x	_____	=	_____
MOON	6	x	_____	=	_____

USE THESE NUMBERS ON THE TEAM RECORD SHEET

JOURNEY TO THE UNKNOWN



I. Topic Area
Astronomy

II. Introductory Statement
Students will learn about the seasons and day and night

III. Math Skills
Measurement
Geometry
Estimating
Adding & Subtracting

Science Processes
Observing
Recording Data
Interpreting Data
Predicting

IV. Materials
planetarium
scissors
paper fasteners
tagboard (manilla document paper)
paste or glue

V. Key Question
Where in the galaxy are you?

VI. Background
The teacher needs to practice with the planetarium before presenting the lesson. The children should know that the earth travels around the sun. They should also know that the earth spins on its axis.

VII. Management
This activity may take 45 minutes or you may extend it to 90 minutes.

VIII. Procedure
Have the children put the planetarium together.
1. Cut the 93 million miles strip first.
2. Cut out the other shapes.
3. Attach the other shapes to the 93 million miles strip: the sun, Venus, and Mercury on one side
4. Discuss the phases of the Moon, eclipses, seasons, the movement of the planet.
5. Add and subtract according to the chart.
6. Figure out time zones and discuss day and night.
7. Discover how many astronomical units the Milky Way is long and all other appropriate studies for your group.

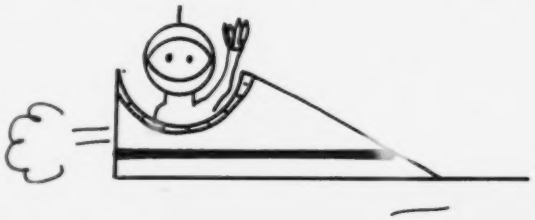
IX. What the Students Will Do
The students will make the planetarium and using the dials find the times and the distances asked for on the worksheet.

X. Discussion
1. What object travels around the earth? (Moon)
2. How many planets are closer to the sun than the earth? (Two) What are they? (Mercury, Venus)
3. How much closer are the two planets to the sun?

(Mercury)	(Venus)
149,600,000 km	149,600,000 km
- 57,900,000 km	- 108,200,000 km
91,700,000 km	41,400,000 km

4. What causes the seasons? (Angle of the sun to the earth)
5. What causes the time zones? (The rotation of the earth)
6. What measure of time does the moon give us? (Month)

XI. Extensions
1. Science — star constellations can be added to show the different appearances and disappearances.
2. Language Arts — read and write stories about space travel.
3. Social Studies — study the famous people of space and the space shuttle.
4. Time — follow shadows.
5. Music — "Star Wars" theme
6. P.E. — what would it be like to walk on the moon? Use an air mattress, no shoes, and one person at a time.



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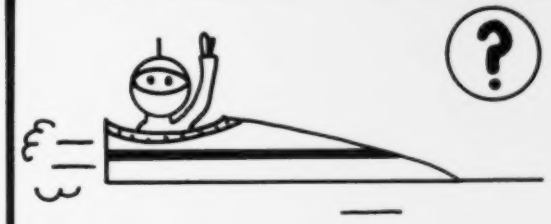

JOURNEY TO THE UNKNOWN

SUN		MERCURY		VENUS		EARTH		MOON		
										TRAVELS AROUND
MILES	KM	MILES	KM	MILES	KM	MILES	KM	MILES	KM	
										DISTANCE FROM THE SUN
										DISTANCE FROM MERCURY
										DISTANCE FROM VENUS
										DISTANCE FROM EARTH

SEASONS	TIME	
		ASIA
		EUROPE
		SOUTH AFRICA
		SOUTH AMERICA

1. WHAT TRAVELS AROUND THE EARTH?
2. HOW MANY PLANETS ARE CLOSER TO THE SUN THAN THE EARTH?
3. HOW MUCH CLOSER TO THE SUN ARE THE TWO PLANETS?
4. WHAT CAUSES THE SEASONS?
5. WHAT CAUSES THE TIME ZONES?

JOURNEY TO THE UNKNOWN
PLANETARIUM PATTERN

45

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HARDHATTING IN A GEO-WORLD

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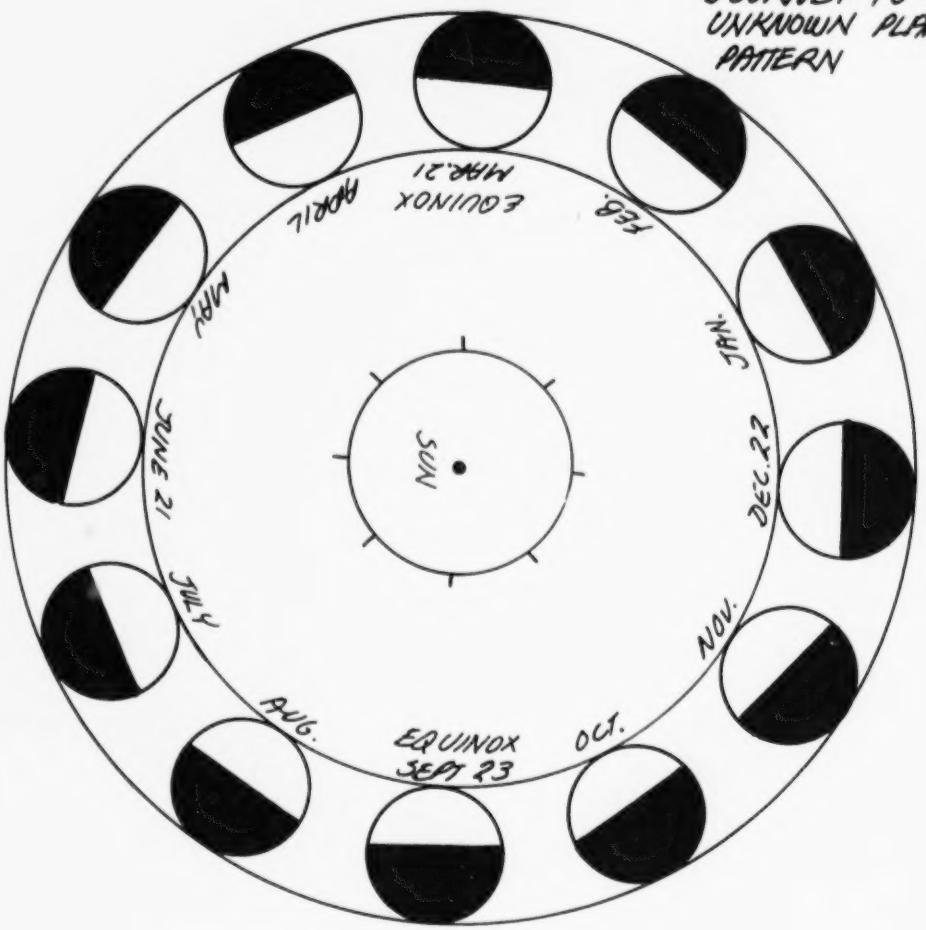
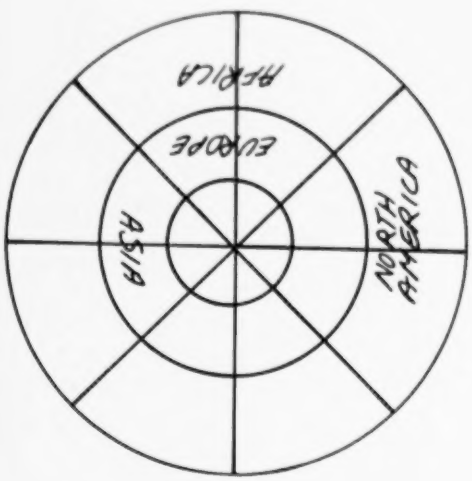
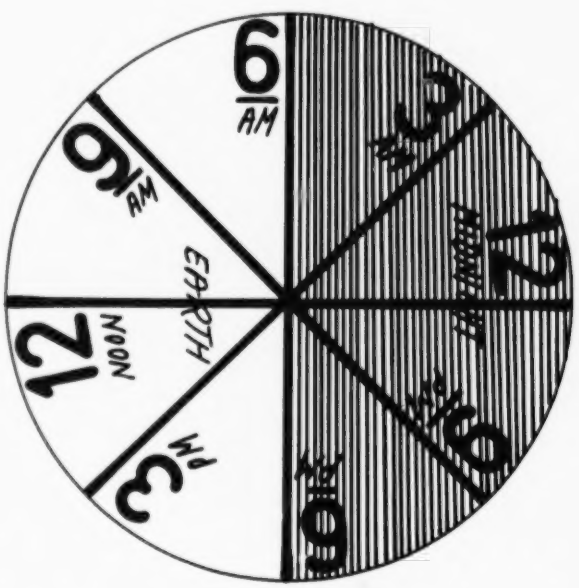
JOURNEY TO THE UNKNOWN PLANETARIUM PATTERN







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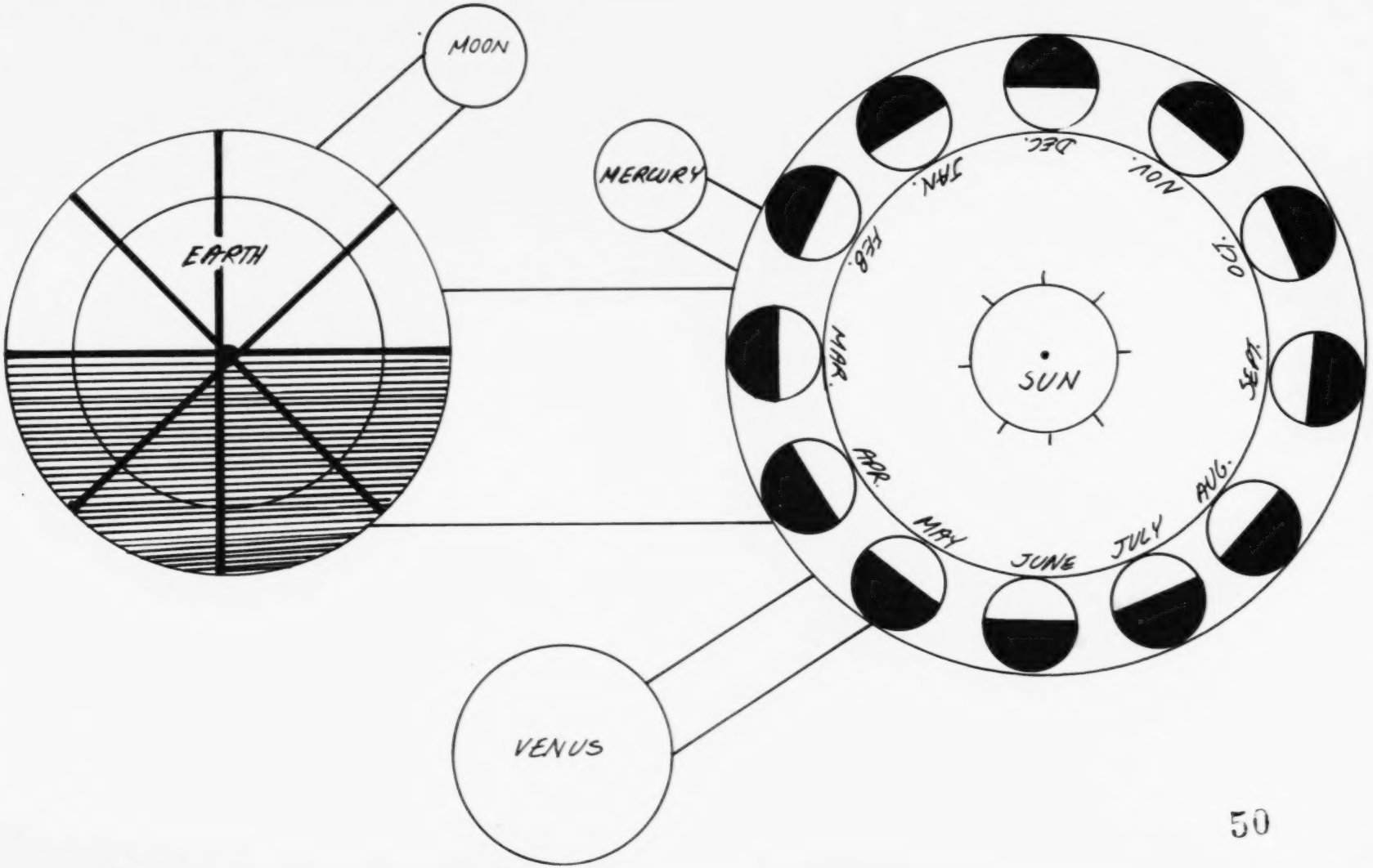
WHEN THE PLANETARIUM IS COMPLETE
IT SHOULD LOOK LIKE THIS:

93 MILION MILES } ONE ASTRONOMICAL UNIT
150,000,000 KM }



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I. Topic Area
Astronomy

II. Introductory Statement
The children will learn to use a map of the moon to describe distances.

III. Math Skills
Measurement
Multiplying

Science Processes
Observing
Recording Data
Interpreting Data

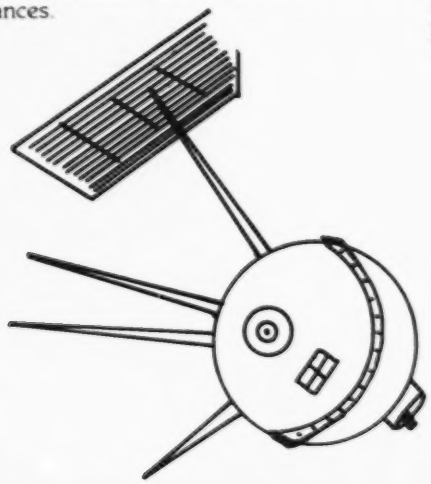
IV. Materials
cm ruler

V. Key Question
Where on the moon is the Bay of Rainbows?

VI. Background Information
The teacher should be familiar with this activity.

VII. Management
This activity may take from 40 to 90 minutes.

VIII. Procedure
1. Have the children use the cm rulers to measure the required distances.



2. Multiply the measured cm by 232 km to find the actual distances on the moon.
3. Discuss the results.

IX. What the Student Will Do
1. Measure the distances in cm.
2. Multiply by 232 to convert to km distances on the moon.
3. Answer the questions.
4. Do the discussion questions.

X. Discussion
1. Where is the Bay of Rainbows?
2. How big is the moon?
3. What other distances can you measure using our moon map?
4. Where is the best place to live on the moon? Why?
5. What phase of the moon is best to travel on the moon? Why?

XI. Extensions
Art — Make a papier maché moon.
Language Arts — Write a story on colonizing the moon.
Math & Science Integrated — Journey to the Unknown, Heavy Work or the Phases of the Moon can be worked on after this activity.

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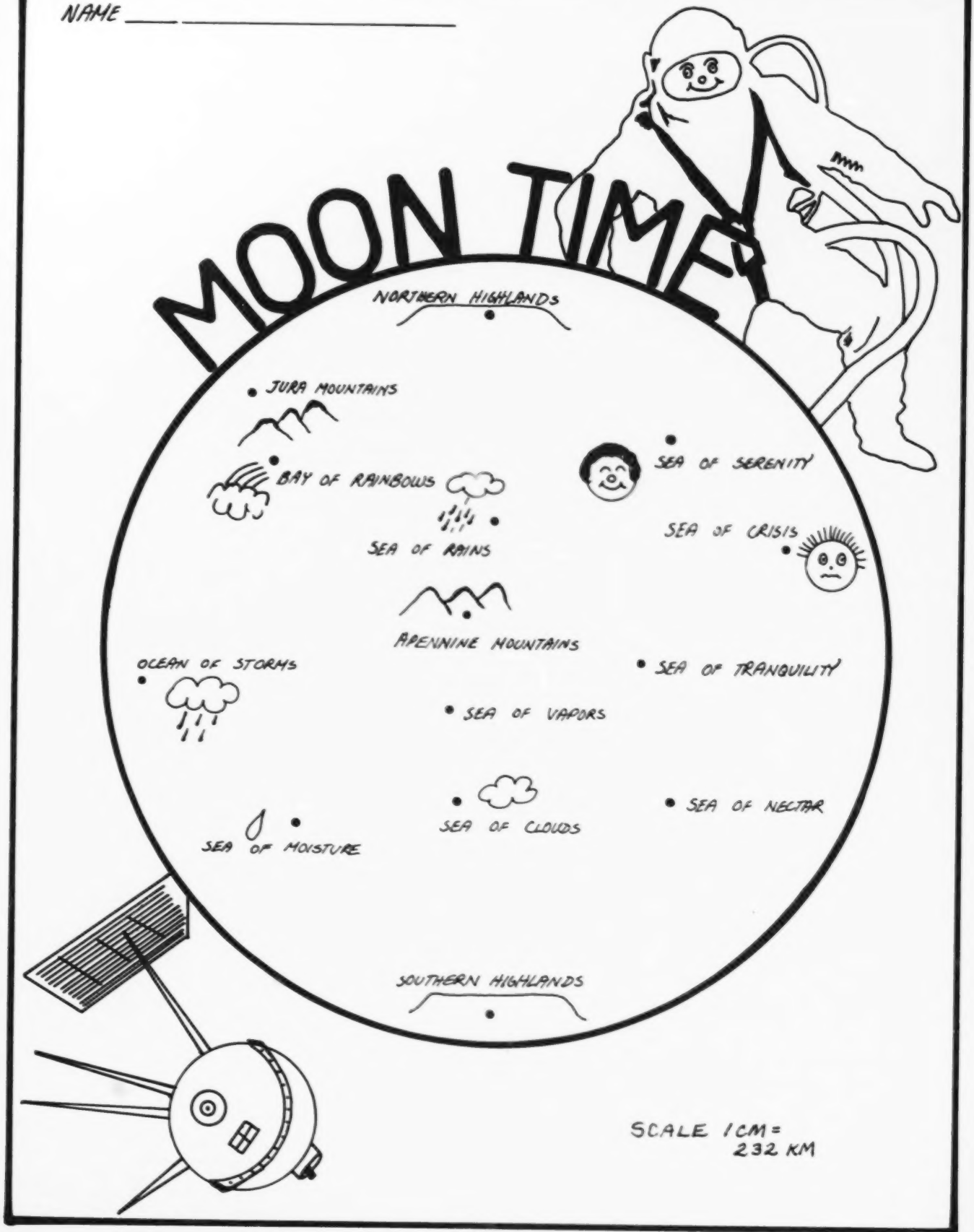

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MOON TIME

1. HOW FAR IN KM, IS IT FROM THE SEA OF RAINS TO THE SEA OF TRANQUILITY?

_____ CM × 232 = _____ KM

2. HOW FAR HAVE WE TRAVELED FROM THE SOUTHERN HIGHLANDS IF WE GO TO THE OCEAN OF STORMS THROUGH THE SEA OF TRANQUILITY?

_____ CM × 232 = _____ KM

3. IF WE TRAVEL FROM THE OCEAN OF STORMS TO THE APENNINE MOUNTAINS TO THE SEA OF CLOUDS, HOW FAR HAVE WE GONE?

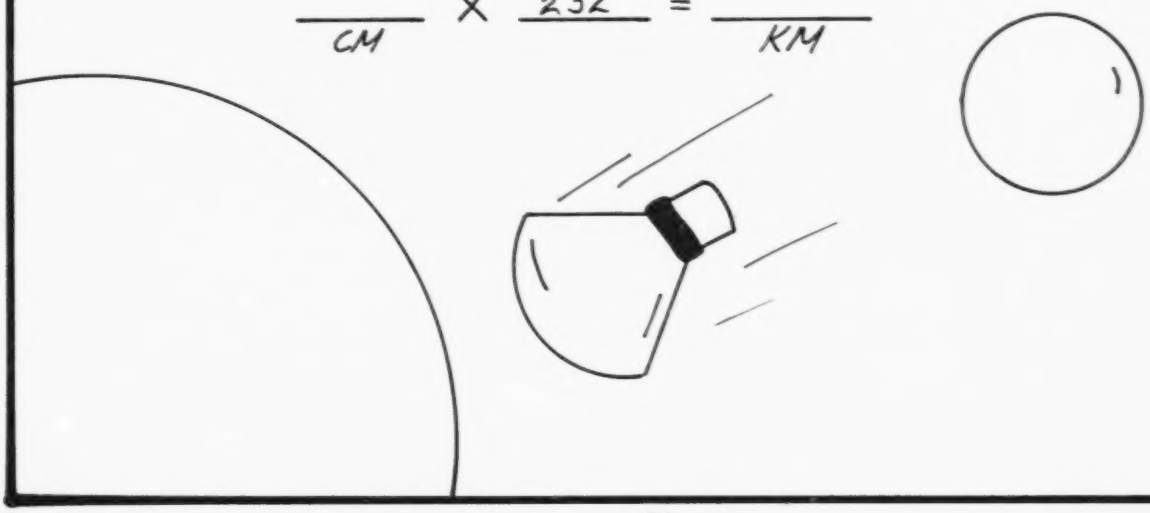
_____ CM × 232 = _____ KM

4. HOW FAR IS IT FROM THE SOUTHERN HIGHLANDS TO THE SEA OF MOISTURE IF YOU GO THROUGH THE SEA OF CLOUDS?

_____ CM × 232 = _____ KM

5. WHAT IS THE DISTANCE FROM THE SOUTHERN HIGHLANDS TO THE NORTHERN HIGHLANDS AND BACK AGAIN?

_____ CM × 232 = _____ KM



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HEAVY WORK

I. Topic Area
Astronomy

II. Introductory Statement
The students will learn what they weigh on different planets.

III. Math Skills
Measurement
Multiplying

Science Processes
Recording Data
Interpreting Data

IV. Materials
kg scale (bathroom scale)

V. Key Question
If you could have your weight in gold, on what planet would you like to get it?

VI. Background Information
Be sure that the children are familiar with the scale you are using.

VII. Management
This activity takes from 40 to 90 minutes to complete.

VIII. Procedure
1. Weigh each child.
2. Use the chart to find out what each child weighs on each planet.
3. Record their work on the graph.
4. Answer discussion questions.

IX. What the Student Will Do
The children will weigh themselves and record their results on the graph and chart. Compare answers by answering the discussion questions.

X. Discussion
1. If you could have your weight in gold, where in the universe would you like to receive it?
2. On which planet are you the lightest? Where do you have no weight at all?
3. Who is the heaviest person on the space shuttle? the lighest?
4. Does the temperature of the place you are affect your weight? Why?

XI. Extensions
1. Visit a planetarium.
2. Language Arts — Write a story about being an alien, an astronaut, or an earthling talking to E.T.
3. Watch the movie E.T. or read the book. How would you react to E.T.?
4. Art — Make a planetarium.
5. Use Journey to the Unknown from this booklet.

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HEAVY WORK

TO FIND YOUR WEIGHT IN SPACE, MULTIPLY YOUR WEIGHT BY THE GIVEN SURFACE GRAVITY FACTOR.*

LOCATION	FACTOR	X	YOUR WEIGHT	=	YOUR WEIGHT IN SPACE
EARTH	1	X		=	
SUN	27.9	X		=	
MOON	.17	X		=	
MERCURY	.4	X		=	
VENUS	.87	X		=	
MARS	.38	X		=	
JUPITER	2.65	X		=	
SATURN	1.14	X		=	
URANUS	1.04	X		=	
NEPTUNE	1.42	X		=	
SPACE SHUTTLE	0	X		=	

* DATA SOURCE: AMERICANA ENCYCLOPEDIA

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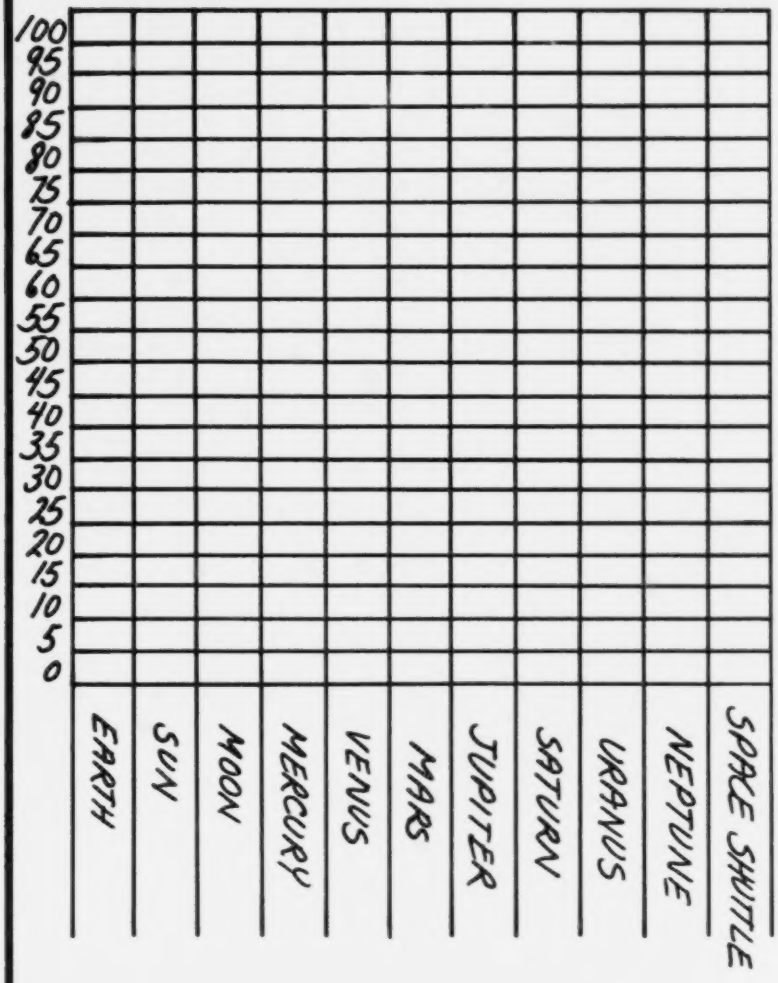
HEAVY WORK



1. ON WHICH PLANET WOULD YOU LIKE TO BE TO GET YOUR WEIGHT IN GOLD?

_____

2. ON WHICH PLANET ARE YOU THE LIGHTEST?

_____

3. WHO IS THE HEAVIEST PERSON ON THE SPACE SHUTTLE?

_____

4. WHO IS THE LIGHTEST PERSON ON THE SPACE SHUTTLE?

_____

5. DOES THE TEMPERATURE OF THE PLANET AFFECT YOUR WEIGHT?

_____ WHY? _____

_____

NAME _____

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METRICALLY CLIPPING

I. Topic Area
Paper clip measurement

II Introductory Statement
The students will learn to use non-standard measures. They will compare their measurements with the metric system.

III. Math Skills
Measurement
Estimating
Graphing
Formulas

Science Processes
Recording Data
Interpreting Data

IV. Materials
math book
student
cm rulers
seven boxes of paper clips

V. Key Question
What is your volume in the metric system?

VI. Background Information
The children should be familiar with the idea of measuring and be given the formula for volume. (LXWXH) They should know that a paper clip is 3 cm long. We are trying to show that a paper clip and a meter are related.

VII. Management
This activity should take 40 to 90 minutes. Extensions will take longer. Do the measurements during the first period and the calculations the second period. Choose the appropriate worksheet.

VIII. Procedure
Measure and estimate at least five objects. Find the volume of the five objects by multiplying. (LXWXH)

IX. What the Students Will Do
1. Estimate the L, W, H of each object in cm and paper clips.
2. Record on worksheet.
3. Measure L, W, H in paper clips and convert to cm.
4. Students will measure and compute the volumes.
5. Then, each will compare their findings by making a graph.

X. Discussion
1. Is your volume like anyone else's?
2. What object in the room has the same volume as your math book?
3. What object in the room has the same volume as you do?

XI. Extensions
1. Use 1,000 centicubes instead of paper clips.
2. Language Arts — Write a story about describing objects metrically.
3. Learn the Metric-y Drag. (Varsity Drag from the movie "Good News").

The Metric-y Drag
(metric words to the Varsity Drag)

1st Verse
Here is the Drag, See how it goes;
Down on the heels, up on the toes.
Follow the footsteps to Metric-y Drag.
Metre to Litre, Centi to Gram!
Deci to Litre, Hecto to Kilo,
Turn and do it over again if you can!
You can pass many a class, whether
you're dumb or wise. If you all
answer the call, when your professor
cries: "Everybody down on your heels,
up on your toes, stay after school, learn
how it goes; Everybody do the Metric-y Drag."
2nd Verse
Here is the Drag, See how it goes;
Down on the heels, up on the toes.
Follow the footsteps to Metric-y Drag.
Metre to Litre, Centi to Gram!
Deci to Litre, Hecto to Kilo,
turn and do it over again if you can!
Down on your heels, up on the toes,
Follow the footsteps —
Metre to Litre, Centi to Gram
"Everybody down on the heels, up on the toes,
Stay after school, Learn how it goes;
Everybody do the Metric-y Drag."

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METRICALLY CLIPPING

ESTIMATE

OBJECTS MEASURED	LENGTH ESTIMATE		WIDTH ESTIMATE		HEIGHT ESTIMATE	
	CLIPS	CM	CLIPS	CM	CLIPS	CM
MATH BOOK						

ACTUAL

	LENGTH ACTUAL		WIDTH ACTUAL		HEIGHT ACTUAL	
	CLIPS	CM	CLIPS	CM	CLIPS	CM
MATH BOOK						

NAME _____

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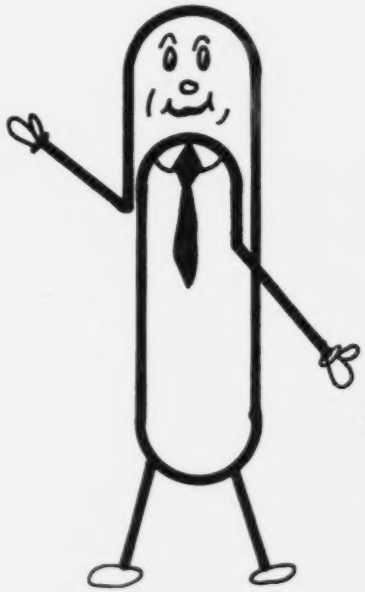
40.

HARDHATTING IN A GEO-WORLD

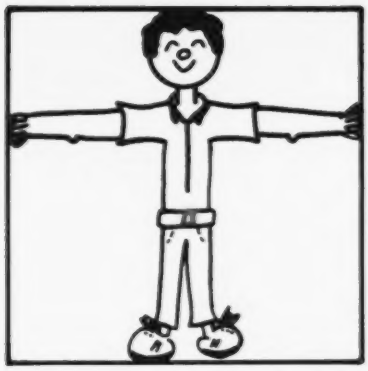
NAME _____

METRICALLY CLIPPING



NUMBER OF CLIPS

ARE YOU A SQUARE?



I. Topic Area
Measurement/Human Body

II. Introductory Statement
Students will discover how their height is related to their arm span.

III.

Math Skills	Science Processes
Estimating	Gathering & Recording Data
Measuring Length	Classifying
Graphing	Interpreting Data

IV. Materials
Metric wall chart and two meter sticks OR four meter sticks for each measuring area desired (tape two vertically for the height measure and two horizontally about student's shoulder height).

V. Key Question
Are you a square?

VII. Management
1. This activity may take 45 to 60 minutes.
2. Use groups of three; two help measure the third person.

VIII. Procedure
1. Discuss how to measure accurately. Measure twice to double-check. Shoes are a variable and should be taken off to measure height.
2. Determine how close measurements have to be to make a square -1 cm? -2 cm? To what unit should measurements be rounded? ½ cm? nearest cm?
3. Help students record on their personal graph (L-shaped).
4. The class graph can be filled by having the squares stand to be counted, then each of the other groups. A class graph with colored paper squares can also be made. Another option is to use the second worksheet to record all results.

IX. What the Students Will Do
1. Students will predict whether they are a square, tall rectangle, or wide rectangle.
2. Groups of three will measure each other's height and arm span.
3. Students will record their own information and fill in the L-shaped bar.
4. Students will decide which shape they are and record.
5. Students will trade papers to check if they made the right decision.
6. As all the squares stand, students will count and record on the class results graph. (Optional — Use second worksheet to record all results.)
7. Repeat for tall and wide rectangles.
8. Students will write two statements about the graph. (most common, least common, etc.)

X. Discussion
1. How close do the measurements have to be to make a square? (within 1 cm? 2 cm?)
2. Should we round our measurements? To what unit?
3. What is the most common shape in our room?
4. Which is most rare?
5. Do you have a twin?
6. Do you think age has anything to do with the results?
7. Would another class have the same results? (See EXTENSIONS)

XI. Extensions
1. Measure another class or adults at school. Compare results. Use the second worksheet to record.
2. Measure your family. Does the same shape run in the family?

XII. Curriculum Coordinates
Art — 1. Outline students' bodies and have them paint life-size replicas or draw their heart, lungs, etc.
2. Create a square, tall rectangle, or wide rectangle picture, design, or collage with construction paper. Use only your shape.

Computer — Do a stick-figure version of yourself using LOGO commands.

Writing — Write to athletes, actors, etc. and ask them to measure and send their arm length and height.

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NAME _____

ARE YOU A SQUARE?

HOW DOES YOUR HEIGHT COMPARE WITH YOUR ARM LENGTH?

PREDICT _____

ACTUAL _____
(SQUARE, TALL RECTANGLE, WIDE RECTANGLE)

HEIGHT

_____ CM

CLASS GRAPH

WHAT DOES THE CLASS GRAPH SHOW?

_____

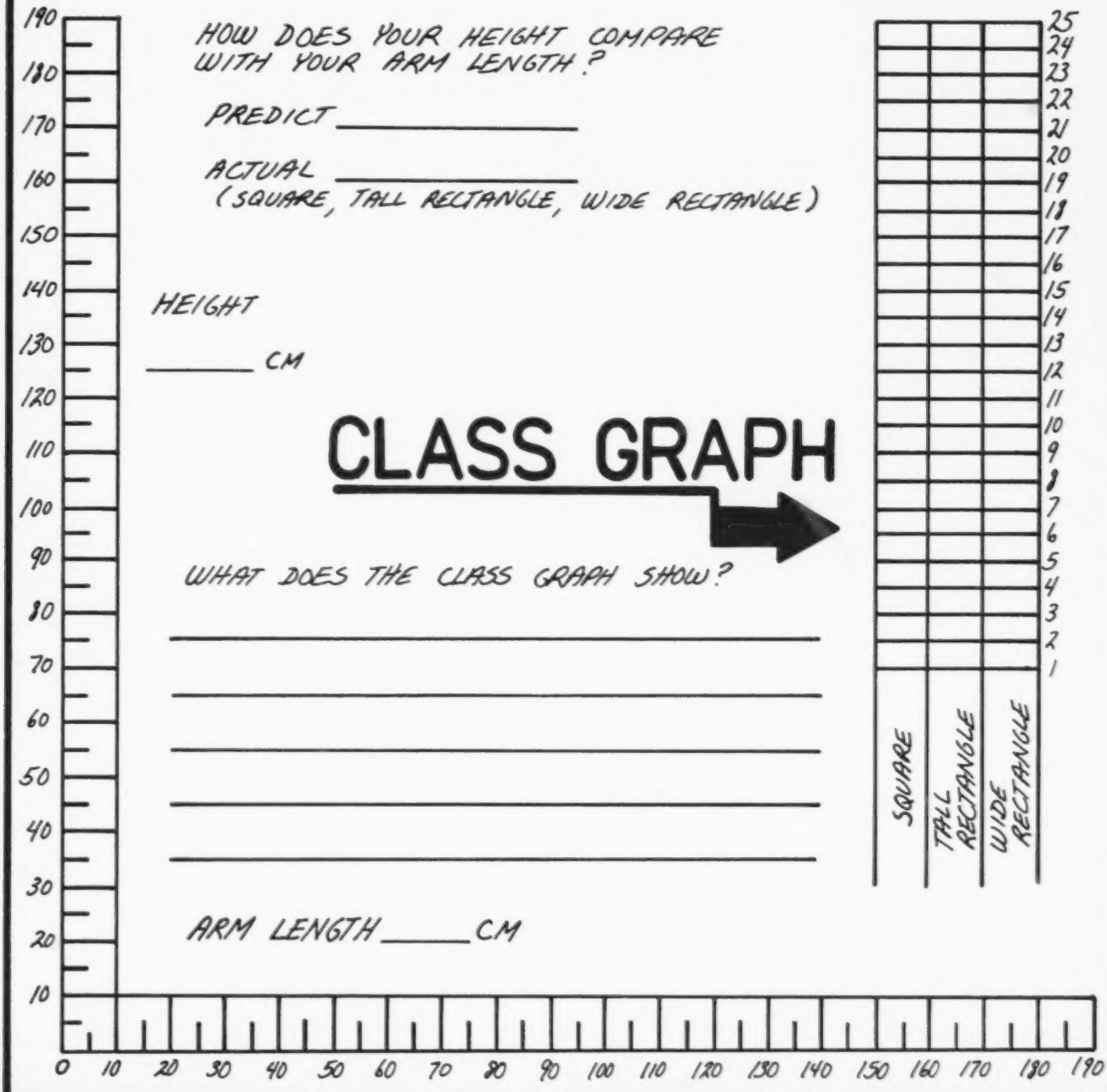
_____

_____

_____

_____

ARM LENGTH _____ CM



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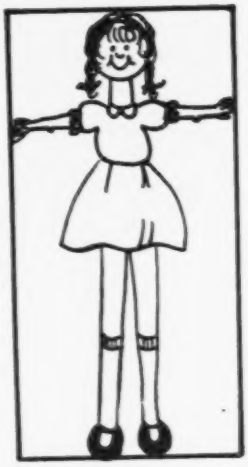

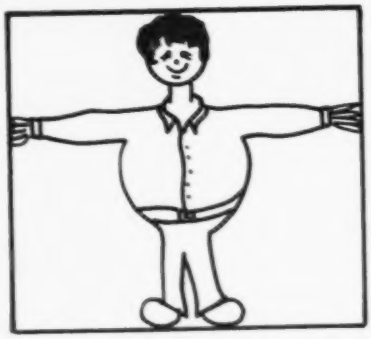

CHECK ONE

NAME	HEIGHT	ARM

BEAR FACTS

I. Topic Area
Metric Measurement

II. Introductory Statement
The students will learn how to use the metric system.

III. Math Skills
Measuring
Graphing
Attributes
Estimating

Science Processes
Recording Data
Observing
Predicting
Interpreting Data

IV. Materials
metric tape measure
bears (any kind: stuffed, plastic, or paper.)
crayons
metric ruler
scissors

V. Key Question
What are the bear facts of meters?

VI. Background Information
The children should bring their bears to school the day before you do this activity. Be sure every child has a bear to work with even if only a paper bear. Go over the metric chart. 100cm = 1m and 10mm = 1cm.

VII. Management
This activity should take one 40 minute period.

VIII. Procedure
Be sure every child has a bear. Be sure that the tape measure, crayons, and scissors are ready to use.

IX. What the Students Will Do
1. Give the bear a name.
2. Measure the bear's length- width- depth as on the bear paper.
3. Record all of the measurements on the bear paper.
4. Measure yourself using the bear as your unit of measure. (LXWXH)

X. Discussion
1. How is your bear different from the other bears?
2. How is your bear like the other bears?
3. How many bears high are you? Wide? Long?
4. Measure yourself in meters. How do you compare in cm to your bear?

XI. Curriculum Coordinates
Language Arts — Cinnamon Bear Tapes (listening skills), Who-What-Where-When-Why, Newspaper, Bear Puns.
Art — Draw pictures of the bears doing different activities. Paper mache bears.
Music — Teddy's Bear Picnic
Social Studies — Walt Disney's Movie "Bear Country".
P.E. — Bear Exercises (stretch and bend).

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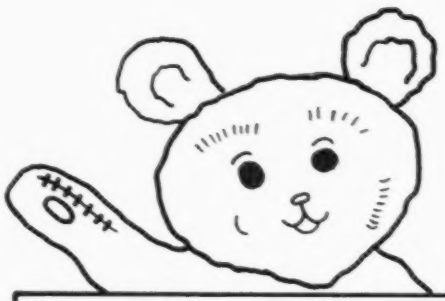
BEAR FACTS



	LENGTH	WIDTH	DEPTH
BEAR	CM	CM	CM
YOU	CM	CM	CM
DIFFERENCE	CM	CM	CM

1. MEASURE YOUR BEAR AND YOURSELF. RECORD YOUR ANSWERS ON THE CHART.

2. HOW IS YOUR BEAR DIFFERENT FROM THE OTHER BEARS? _____

3. HOW MANY BEARS TALL ARE YOU? _____ WHAT PART OF YOUR BODY IS THE SAME SIZE AS YOUR BEAR? _____

4. HOW MANY BEARS MAKE ONE PERSON? _____

FIND THE AVERAGE HEIGHT OF EVERYONE IN YOUR GROUP IN BEARS. THE ANSWER WILL EQUAL ONE PERSON.

EXAMPLE: IF YOU ARE 10 BEARS HIGH AND YOUR FIVE FRIENDS ARE 12, 13, 17, 8, 6 RESPECTIVELY, YOUR AVERAGE IS FOUND LIKE THIS:

$$\begin{array}{r} 10 \\ 12 \\ 13 \\ 17 \\ +\ \ 8 \\ +\ \ 6 \\ \hline 66 \end{array}$$

$$6\overline{)66} \quad \begin{array}{r} 11 \\ -6 \\ \hline 6 \\ -6 \\ \hline \end{array}$$

11 BEARS = 1 PERSON

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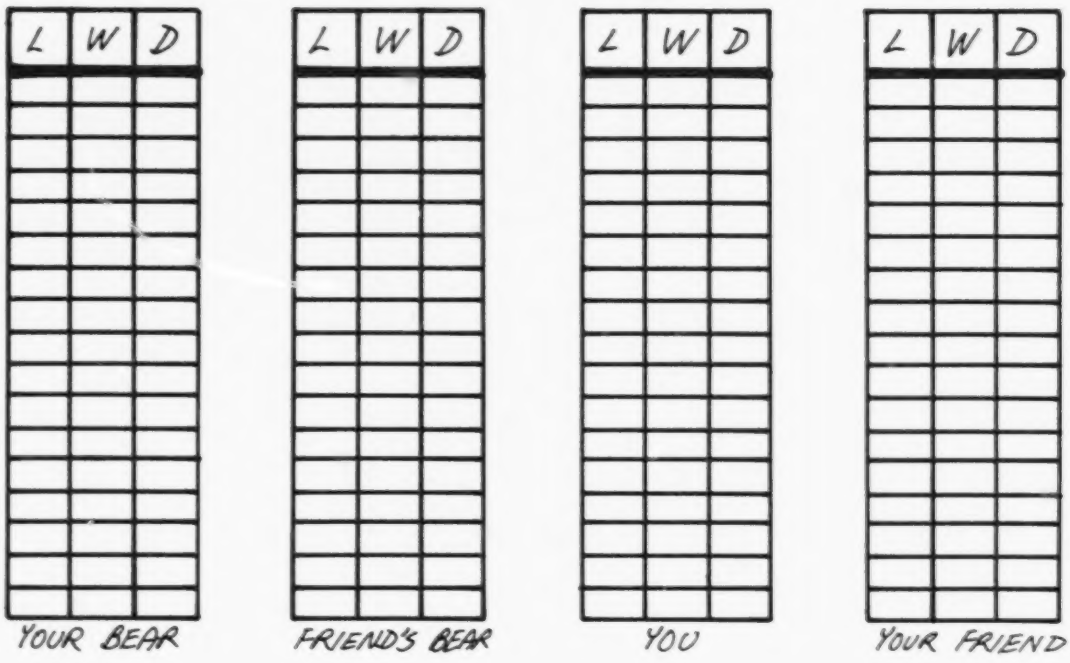
NAME _____

BEAR FACTS



ADD YOUR BEAR TO YOUR FRIEND'S BEAR LENGTH.

1. WHAT IN THE ROOM IS THAT TALL? _____

2. WHICH PERSON IN THE ROOM IS THAT TALL? _____

ADD YOUR LENGTH TO YOUR FRIEND'S.

3. WHAT OBJECT IN THE ROOM IS THAT TALL? _____

4. WHICH PERSON IN THE ROOM IS THAT TALL? _____

ADD YOUR BEAR'S LENGTH TO YOURS.

5. WHAT OBJECT IN THE ROOM IS THAT TALL? _____

6. WHICH PERSON IN THE ROOM IS THAT TALL? _____

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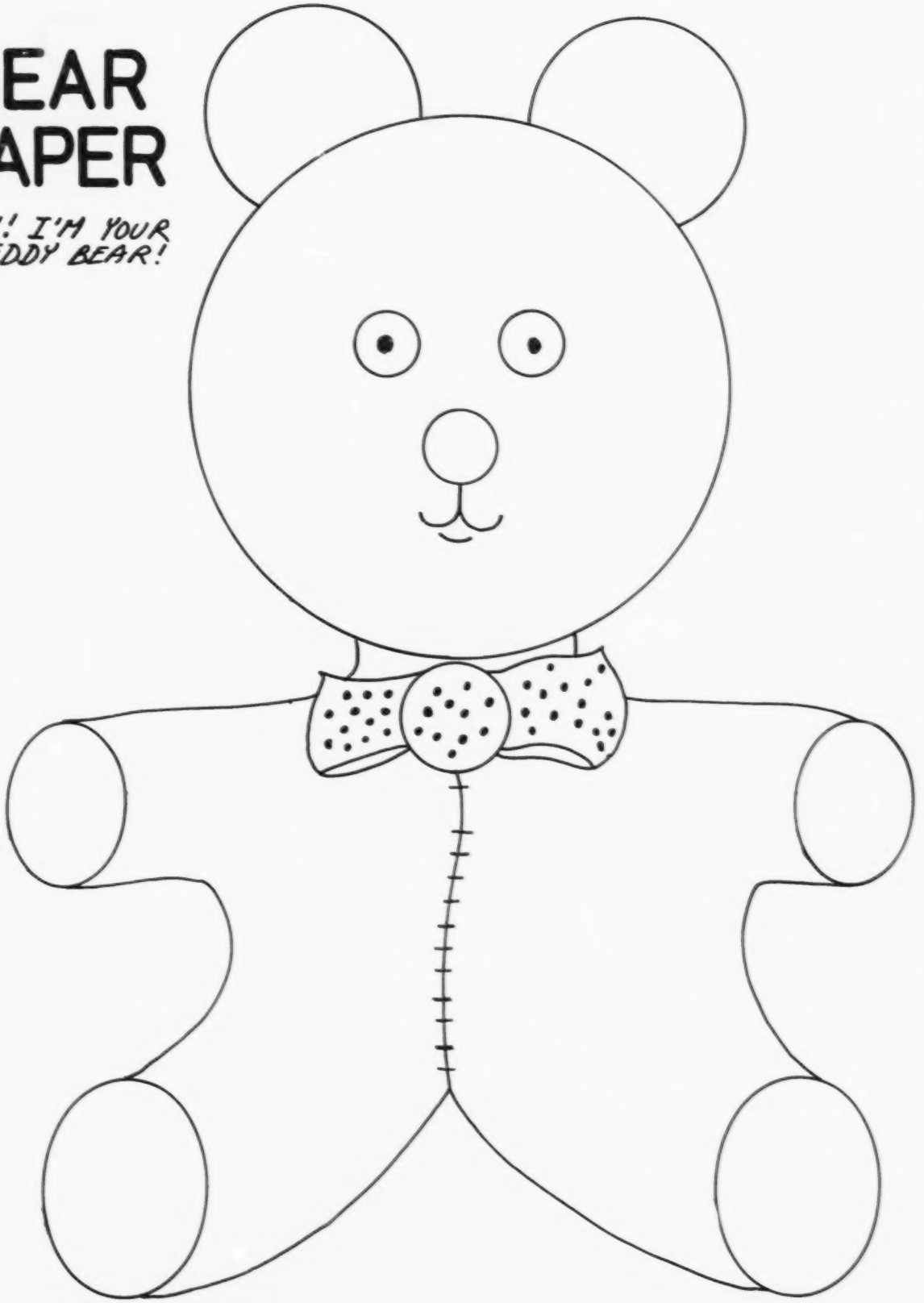
BEAR PAPER

HI! I'M YOUR TEDDY BEAR!



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HAVE YOU GOT A MINUTE?

I. Topic Area
Timing what we can do.

II. Introductory Statement
Students will learn what they can do in one minute.

III. Math Skills
Counting
Graphing
Timing
Estimation

Science Processes
Recording Data
Observing
Measuring

IV. Materials
stopwatch
two balls
small race cars

V. Background Information
Be sure your students can physically do the activity for one minute.

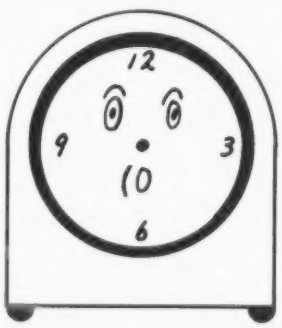
VI. Key Question
What can I do in one minute?

VII. Management
This activity takes 40 minutes.

VIII. Procedure
1. Run in place, counting the number of times the child's foot hits the floor.
2. Untie or unbuckle one shoe and count how many times you can tie and buckle your shoe in one minute. (If you have slip-ons borrow the foot of a friend.)
3. Raise your right foot and count how many hops you can do in one minute.
4. Toss one ball in the air and catch it. Count how many times you can do this in one minute.
5. Take a second ball and toss two balls in the air counting how many times you can do this in one minute.
6. Put a meter stick on the floor. Start your race car from the 1 cm mark and see how far you can move it without touching it.
7. Discuss the results and graph them.

IX. Discussion
1. How much can you do in a minute?
2. How long is a minute?
3. Can you do more with your minutes in a day? Why?

X. Curriculum Coordinates
1. P.E. — Exercises
2. Social Studies — Group activity
3. Language Arts — Write a story about all the things you can do in a minute. Read and discuss the the poem "For the want of a Penny the War was Lost".
4. Music — Play the minute waltz. Does it only take a minute?



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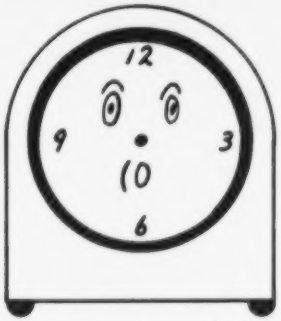

HAVE YOU GOT A MINUTE?

NAME OF ACTIVITY	TIME	HOW MANY?	
		GUESS	RESULT
1. RUN IN PLACE	60 SEC.	STEPS	STEPS
2. SHOE TIE	60 SEC.	BOWS	BOWS
3. HOP ON ONE FOOT	60 SEC.	HOPS	HOPS
4. TOSS ONE BALL	60 SEC.	CATCHES	CATCHES
5. TOSS TWO BALLS	60 SEC.	CATCHES	CATCHES
6. RACE CARS	60 SEC.	M	M

1. WHAT ELSE CAN YOU DO IN 60 SEC.? NAME A LEAST THREE THINGS.
_____ _____ _____

2. WHAT PART OF THE DAY IS 60 SEC.? _____

3. WHAT CAN OTHER PEOPLE DO IN 60 SEC.? NAME TWO. _____ _____

4. IS 60 SECONDS REALLY A LONG TIME? WHY?

5. HOW MANY 60 SECONDS DID IT TAKE TO FINISH THIS WORKSHEET? WHY?

6. MAKE A GRAPH SHOWING WHAT YOU CAN DO IN A MINUTE.

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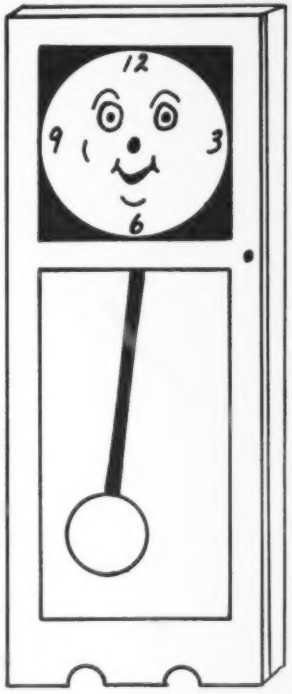
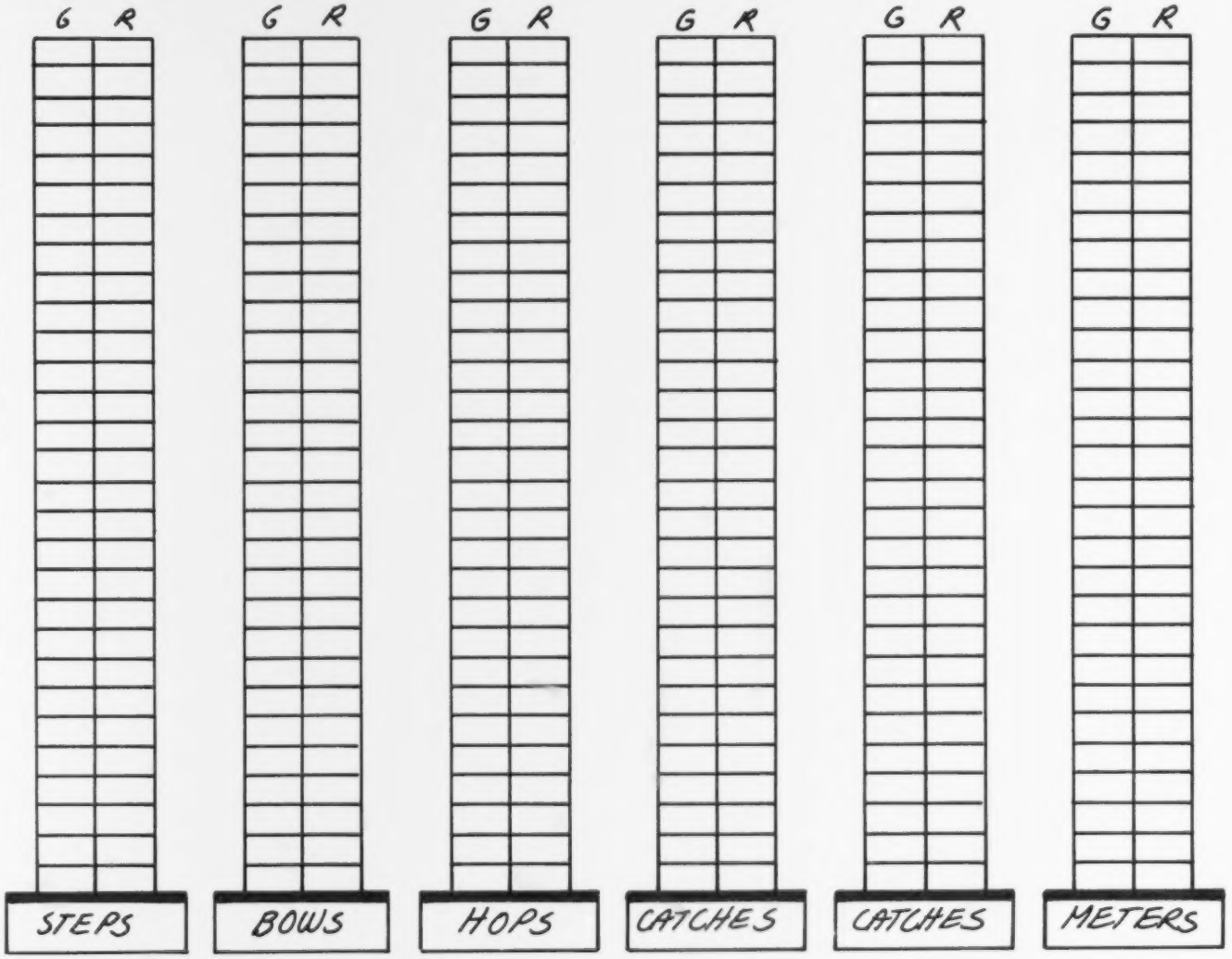
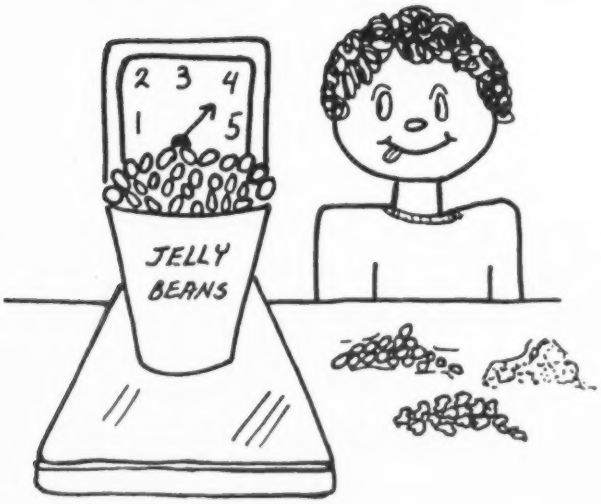




VOLUMES OF FUN



I. Topic Area
Estimating and measuring weight

II. Introductory Statement
Students will learn that things of equal volume do not always have the same weight because of differences in density.

III. Math Skills
Estimating
Measuring
Subtraction
Division

Science Processes
Observing
Recording Data

IV. Materials
jelly beans
shelled peanuts
raisins
dried beans
sand
metric scale — equal arm balance
set of grams of varying weights
styrofoam cups for measuring
student worksheets for each child

V. Key Question
Does one cup of everything weigh the same?

VI. Background Information
Weight is the force on an object due to the pull of earth's gravity. The farther an object gets from the center of the earth the less it weighs. Weight can change. Objects are weightless in outer space. Objects at the equator weigh less than at the poles because the poles are closer to the earth's center.

Mass is not weight. It is usually defined as the amount of matter in an object. It does not change like weight, but remains constant.

Volume is the amount of space a body occupies. It is measured in cubic units. There are several ways to figure it because the shape of the substance determines which formula to use. Another factor is the form it's in such as solid or liquid.

Density is the relation between the amount of matter (mass) and the size or volume of a substance. To get the density you would divide the weight of the mass by the volume in cubic units. There is more to finding specific density.

On the student worksheets the children will estimate the weight of each cup of substance and compare it with its actual weight by finding the difference or the error.

VII. Management
This investigation can be done with the entire class or with smaller groups. It can be done in a 45 minute session.

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VIII. Procedure

1. Have all of the things listed under Section IV, Materials, with you in front of the students.
2. Hand out the student worksheets.
3. Explain them briefly.
4. Write the Key Question on the chalkboard and have a short discussion of it.
5. Fill the styrofoam cups with each substance and discuss whether the children think they will all weigh the same because they all have the same volume. Be sure they know what volume is and how many ounces the styrofoam cups are supposed to hold.
6. Ask the children to list the substances on their worksheets beginning with the heaviest to the lightest on a scale from 1 to 5.
7. Next ask them to estimate how much they think each substance weighs in grams.
8. After recording their estimates, the weighing can be done as a whole class or in small groups at separate weighing stations.
9. Be sure students record the actual weights after each weighing.
10. After the weighing and recording is done, the results should be discussed.

IX. What the Students Will Do

1. The students will participate in any discussions the teacher initiates.
2. The students will list the substances in order on their papers from the heaviest to the lighest.
3. They will observe, make estimates, record the estimates, weigh the substances, and record the actual weight.
4. They will subtract to find the difference or error. They will record the error.
5. They will divide the difference by the actual mass in grams to find the ratio.
6. They will record the ratio. (Doing the ratio is optional.)
7. They will discuss the results.

X. Discussion

1. Did the investigation answer the key question?
2. Why didn't they all weigh the same? Discuss mass and density; discuss weight and volume. Apply it to the investigation.

XI. Extensions

1. The class could go on and find the density for each of the items: a. Of course this would be a bit advanced for some students. b. It would be a good introduction to cubic measure.
2. Doing some experimentation with water displacement would introduce the concept of specific gravity.

XII. Curriculum Coordinates

Language

a. Answer a given set of questions about the investigation on paper using full sentences which would be checked for capitalization and punctuation.
b. Write a brief paragraph about the investigation and the student's reactions to it.

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VOLUMES OF FUN

ARRANGE THE LIST OF ITEMS FROM HEAVIEST TO LIGHTEST.

ITEMS	EST.	ACTUAL
JELLY BEANS		
RAISINS		
DRIED BEANS		
SHELLED PEANUTS		
SAND		

SUBSTANCE	EST. WEIGHT IN GRAMS	ACTUAL WEIGHT IN GRAMS	DIFF. E - A	RATIO
JELLY BEANS				
RAISINS				
DRIED BEANS				
SHELLED PEANUTS				
SAND				

_____ ÷ 5 = _____
TOTAL DIFF. AVERAGE DIFF.

_____ ÷ 5 = _____
TOTAL RATIO AVERAGE RATIO

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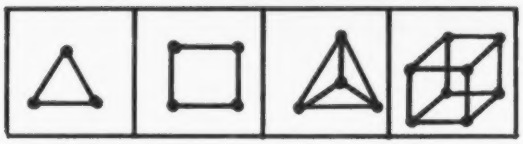
GEO-PANES



I. Topic Area

Geometry/Surface Tension

II. Introductory Statement

Students will discover unique "bubble" patterns formed inside polyhedrons (poly - many, hedron - sides, polyhedron = many sided figure).

III. Math Skills

Geometric shapes & Vocabulary
Counting

Science Processes

Predicting
Observing
Recording Data
Generalizing

IV. Materials

clay
toothpicks
large containers such as ½ gallon milk cartons (1 per group)
liquid dish soap
thread
liter and 15 ml measures, optional
newspaper, optional
scratch paper, optional

V. Key Question

What kind of geo-pane can be made with a 3-D shape?

VI. Background Information

Geo-panes are defined as the pattern of "panes" created by dipping shapes into a water and soap solution.

Patterns which would be expected to form around the sides meet instead near the center, sometimes forming another geometric pattern. This illustrates the principles of surface tension. The elastic, rubbery skin formed by the attraction of molecules to one another is pulling itself into the smallest area possible. Less area is used when the soap film comes toward the center than by covering the faces around a geometric shape.

A second discovery can be made regarding the relationship of vertices, edges, and faces for 3-D figures. Euler's (pronounced "oilers") Theorem states that

vertices + faces = edges + 2

This is true for all convex polyhedrons.

VII. Management

1. This activity may take from 60 to 90 minutes.
2. Shapes will be made individually but groups of three to four can share one container.
3. Caution students to dip carefully so the mixture's surface stays as bubble-free as possible.
4. Students should use smaller sections of toothpicks to make more complex designs; they may need help drawing additional shapes.

VIII. Procedure

1. Spread newspaper to cover tables (or floor) to be used for dipping, preferable away from desks OR plan to do the dipping outside if it's not windy.
2. Use scratch paper to protect desks while rolling clay. Pass out clay, toothpicks, and about 50 cm of thread per person.
3. The teacher or a student can measure about one liter of water and 15 ml or more of liquid soap into each container. Fifteen ml of granulated sugar or glycerin (obtainable at drugstores) may be added to strengthen the mixture. Stir gently without forming bubbles on the surface.
4. The teacher will dip the flat triangle and square in front of the class. For the purposes of this investigation, the resulting "pane" will be called a geo-pane. Discuss results before writing predictions for the 3-D shapes.
5. Discuss the difference between 2-dimensional and 3-dimensional shapes.

IX. What the Students Will Do

1. Students will build the shapes shown on the worksheet using toothpicks and clay balls.
2. Students will fill in the chart.
3. Students will observe the teacher dipping the 2-dimensional shapes in the mixture.
4. Students will predict what will happen when 3-D shapes are dipped.
5. Students will hang shapes from an untied thread and dip into the water-soap mixture.
6. Students will dip each shape in several times and record observations.
7. Students may build additional shapes and observe the results.

X. Discussion

1. Is the geo-pane pattern the same each time? (usually, but a change in conditions - soap bubbles, wind, etc. - can cause differences)
2. How could you change the geo-pane pattern? (changing the position of the thread, popping one pane, blowing on it, etc.)

XI. Extensions

1. Find a pattern relationship between vertices, edges, and faces. See Background Information.
2. Time how long the bubbles last. How could you make them last longer?

XII. Curriculum Coordinates

Art:

1. Build 3-D geometric figures out of paper. This is also a good preliminary activity.
2. Make stained glass windows.

Computer:

1. Create 3-D geometric figures using LOGO.

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GEO-PANES

WHAT KIND OF GEO-PANE CAN BE MADE WITH A 3-D SHAPE?

1. BUILD THESE SHAPES WITH TOOTHPICKS AND 1 CM. CLAY BALLS. FILL IN THE CHART.

2. HANG EACH SHAPE FROM A THREAD AND DIP COMPLETELY INTO A WATER AND LIQUID SOAP MIXTURE. LIFT IT OUT.

SHAPES	△	□				
# POINTS / VERTICES (CLAY BALLS)						
# LINE SEGMENTS / EDGES (TOOTHPICKS)						
# FACES (SIDES)						

WHAT DO YOU THINK WILL HAPPEN? _____

_____

_____

WHAT HAPPENED? _____

_____

_____

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MOEBIUS FACTS

I. Topic Area
Geometry—Moebius Strips

II. Introductory Statement
Students will learn about the peculiar Moebius strip by carrying out various cutting and observing activities.

III. Math Skills
Geometry
Closed Surfaces
Counting
Fractions 1/2, 1/3

Science Processes
Predicting
Gather Data
Recording Data
Observing
Drawing Conclusions

IV. Materials
paper for making strips (butcher paper, adding machine tape, construction paper, etc.)
2 inches wide and 18-24 inches long
5 strips of paper per students
scotch tape
scissors

V. Key Question
What could we do to a piece of paper to make it have only one side?

VI. Background Information
The Moebius strip was discovered by August Ferdinand Moebius, a German mathematician and astronomer, in 1858. Unlike a regular sheet of paper, it does not have a top or bottom, or a front or back. A Moebius strip is a piece of paper having only one side. You can draw a line from any point on this sheet to any other point without crossing an edge. When you change the number of twists and the way in which the cuts are made, you can have some fun with the peculiar Moebius strip.

VII. Procedure
1. You can make a Moebius strip with any reasonable size or type of paper. Adding machine tape two inches wide and 18-24 inches long is easy for students to handle.
2. Label each end of the strips as illustrated.

3. Use the first strip to make a ring or band with no twists. Tape the ends together making sure you tape all the way across both sides of the strip.
4. Predict what will happen when you draw a line down the center and cut on that line. Record your prediction.
5. Cut and record your results.
6. Use the second strip to make another ring. Before you tape the ends together, give one end a half-twist. Check to make sure both sets of letters are visible. The blank sides should be on top of each other.
7. TAPE ALL THE WAY ACROSS BOTH SIDES OF THE STRIP. (NOTE: if you do not tape all the way across the strip, it may fall apart when certain cuts are made.)
8. Predict what will happen when you draw a line down the center of your Moebius strip. Draw the line. Is there a surface that remains without a line? You will find that you went all the way around the entire surface without crossing an edge. Hence, a paper with only one side.
9. Predict what will happen when you cut lengthwise along the line you drew. Record your prediction.
10. Poke the scissors in to start and cut along the line. Record your results.
11. Make another band with the same half-twist. Predict what will happen when you cut it lengthwise one-third of the way in instead of a center cut. Record your prediction.
12. Poke your scissors in and cut one-third of the way in from the edge, and cut around the strip two complete times.
13. Complete the table by making, twisting, and cutting additional strips with the specified format.

IX. What the Students Will Do
see instructions above

X. Discussion
1. What unexpected results did you get when you drew the line down the center of the second strip?
2. What unexpected results did you get from cutting the second strip down the center?
3. Is the resulting loop one-sided or two-sided? Draw a line to find out.
4. How did your prediction differ from the results when you cut one-third of the way in from the edge?
5. Are the resulting loops one-sided or two-sided? Draw a line to find out.
6. How were the results alike when you used two half-twists?

XI. Extensions
1. Try extending the table using three half-twists.
2. Use a strip with one half-twist and try cutting around twice from the beginning.
3. Draw conclusions about the number of surfaces with an odd number of cuts and the number of surfaces with an even number of cuts.

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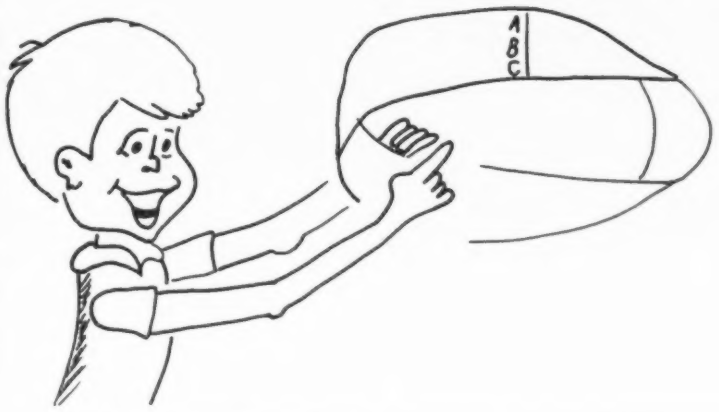
MOEBIUS FACTS



NUMBER OF ½ TWISTS	KIND OF CUT	PREDICTED RESULTS	RESULTS OF CUT LENGTH AND WIDTH, NUMBER OF LOOPS, TWISTS, KNOTS
0	CENTER		
1	CENTER		
1	ONE THIRD		
2	CENTER		
2	ONE THIRD		

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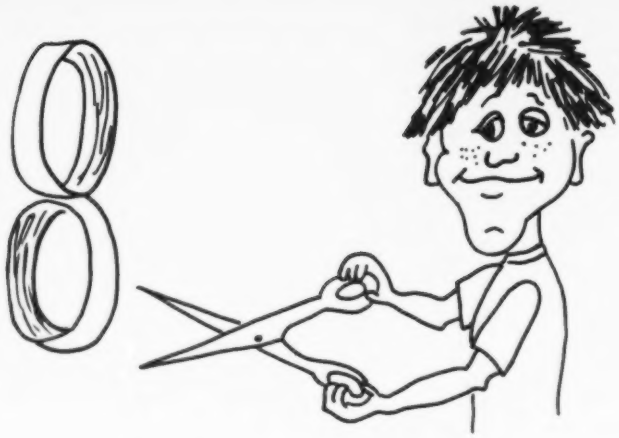

SLICE ME TWICE

I. Topic Area

Geometry: square, rectangle, rhombus, parallelogram

II. Introductory Statement

Students will discover the pattern for determining the construction of a square, rectangle, rhombus, and parallelogram. Students will identify properties of each of the above shapes.

III. Math Skills

Geometry
Construction & Properties
- square
- rectangle
- rhombus
- parallelogram

Science Processes

Observing
Gathering Data
Recording Data
Predicting
Drawing Conclusions

IV. Materials

8 strips of paper per student - two colors (1" X 11")
scotch tape
scissors

V. Key Question

Find the pattern that tells what shape will result when you cut two attached circles down the center.

VI. Background Information

Properties of shapes:

Rectangle: four right angles
four straight sides
opposite side parallel
opposite sides are equal in length

Square: a rectangle
four equal sides
four right angles

Rhombus: four equal sides
opposite sides parallel
a parallelogram

Parallelogram: opposite sides equal
opposite sides equal
opposite sides parallel
a quadrilateral

A rectangle is a special parallelogram. A square is a special rectangle, parallelogram, and rhombus.

VII. Management

One class period of 60 minutes.

VIII. Procedure

1. Pass out two strips of paper. (one of each color)
2. Make two separate circles the same size. Tape ends on both sides all the way across.
3. Put one circle on top of the other at 90° angles.
4. Reach inside the top circle and tape both edges to the bottom circle. Turn over and tape inside edges. If figure is held by the top loop, the middle section is taped together.
5. Slightly pinch one circle and snip in the center. Insert scissors and cut all the way around the center of the circle.
6. Let figure open. You should have a straight strip with a loop at each end.
7. Cut the straight piece down the center.
8. Unfold carefully.
9. Name the shape.
10. What will happen if we start with one circle larger than the other?
11. Repeat the process cutting some off of one of the strips before taping them into circles.
12. Name the shape.
13. What will happen if we tape them at angles other than 90°?
14. Repeat process with equal circles taped at about 45° angles.
15. Name the shape.
16. What will happen if one circle is larger than the other and we use an angle other than 90°?
17. Repeat process with one circle larger than the other and tape at about 45° angles.
18. Name the shape.

IX. What the Students Will Do

same as above

X. Discussion

Discuss the properties of each shape. (see background information) Compare the shapes to one another. Discuss why a square is a rectangle, a rectangle a parallelogram, a rhombus a parallelogram, etc.

XI. Extension

1. Is it possible to make a triangle?
2. What happens when you put a circle inside the top circle?
3. Experiment and record your results.

XII. Curriculum Coordinates

Write a book about geometry. Illustrate your definitions. Write riddles using the properties. Who am I?

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FIVE SQUARE

I. Topic Area
Geometry

II. Introductory Statement
Students will discover the twelve pentomino shapes.

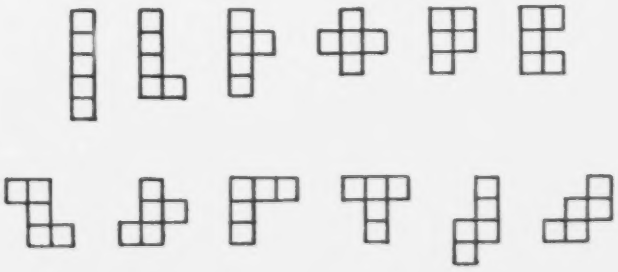
III. Math Skills
Estimating
Geometric Patterns
Problem Solving

Science Processes
Observing
Recording Data

IV. Materials
2 cm graph paper, 1-2 pieces per student
(master included - run on colored construction paper)
scissors
crayons
envelopes, optional

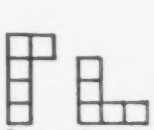
V. Key Question
How many different pentominoes are there?

VI. Background Information
While exploring polyominoes you will find there is only one domino (made of two squares), two triominoes (three squares), five tetrominoes (four squares), and twelve pentominoes (five squares). See Procedure 1. You may wish to discover how many hexominoes can be made. No formula has yet been derived for mathematically determining how many polyominoes are possible for a given number of connected squares.



VII. Management
1. This activity may take 45 to 75 minutes.
2. This activity can be done with the whole class; each student can work individually.

VIII. Procedure
1. Introduce the word "pentomino" and discuss the rules:
   a. Squares must touch on one complete side.
   b. If a shape can be fit on top of another using a flip or turn, it is considered to be the same pattern.



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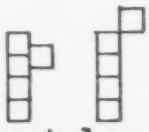

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2. Encourage students to conserve graph paper space; however some will need a second sheet to finish.
3. Emphasis is on discovery; do not give any clues as to how many pentominoes can be made. Toward the end of the discovery period, you may ask questions such as "Who can find the 13th pentomino?" so exploration will continue until the students are absolutely convinced all the pentominoes have been found.
4. Students can store pentominoes in envelopes for further investigations or extensions. It is helpful to give each shape a letter name.

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IX. What the Students Will Do

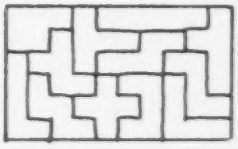
1. Students will predict the number of possible pentominoes.
2. Students will discover and cut out all possible five-square patterns.
3. Students will record patterns by drawing on the worksheet.
4. Students will record the actual number of pentominoes they have discovered.

X. Discussion

Is there an orderly way to search for all the pentominoes? (start with five squares lined up, then all the possibilities for four squares in a line, three squares in a line, etc.)

XI. Extension

1. Use all twelve pentomino pieces to make a rectangle. A 6 X 10 unit rectangle is included; it has over 1,000 solutions. There are also solutions for 5 X 12, 4 X 15, and 3 X 20 rectangle sizes. These are unit sizes (one unit being the length of the side of a square), not metric measurements.



One Solution (6x10)

2. Compare the perimeters of each pentomino if pentomino A is one unit wide and five units long. A unit is defined as the length of the side of a square. The results are very interesting.

3. Explore triominoes, tetrominoes, or hexominoes.

XII. Curriculum Coordinates

Art: Use one pentomino piece and decide what it could be. Trace, then draw a picture around it.

Language: Write a story to go with the above picture.

Computer: Write LOGO programs for the pentomino shapes.

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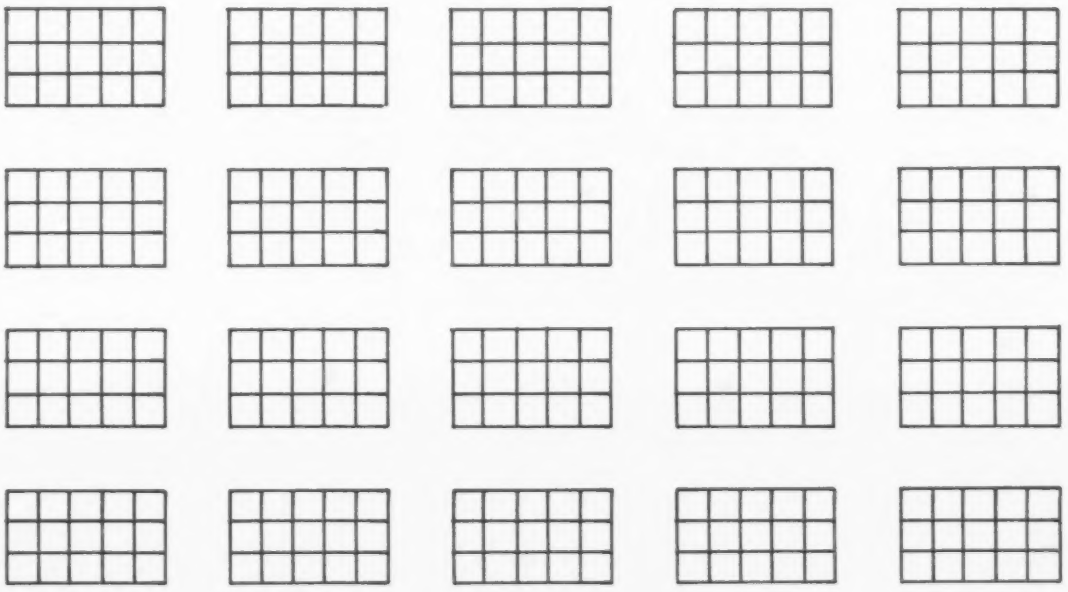
NAME _____

FIVE SQUARE

HOW MANY DIFFERENT PENTOMINOES ARE THERE ?

PREDICT _____ ACTUAL _____



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FIVE SQUARE

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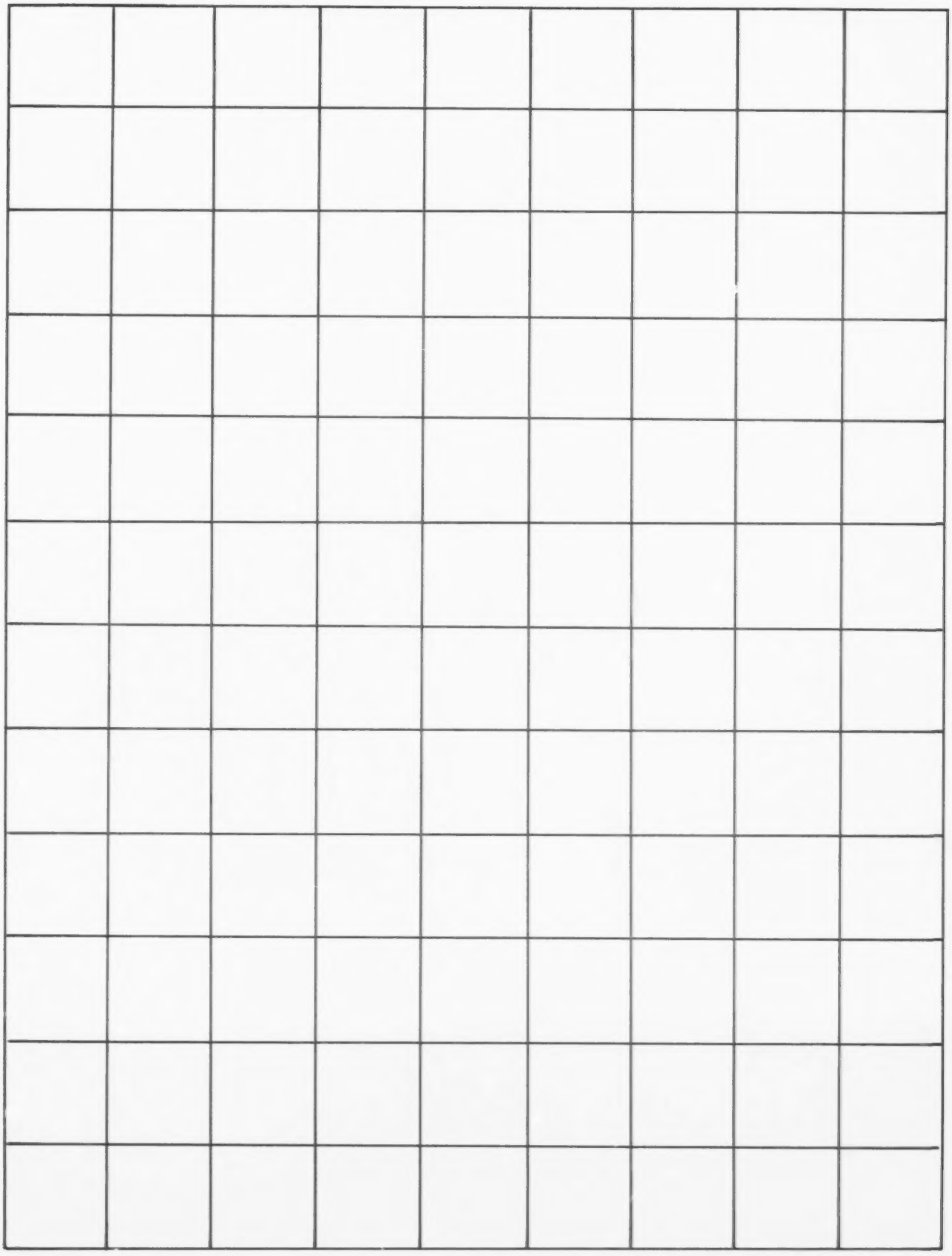

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BOXED IN

I. Topic Area
Geometry

II. Introductory Statement
Students will classify pentominoes into two groups, those that form boxes when folded and those that do not.

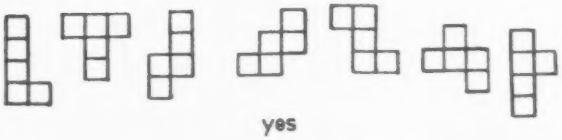
III.

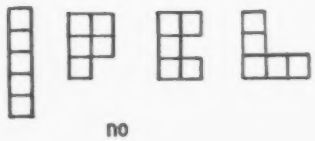
Math Skills	**Science Processes**
Geometric Shapes	Observing & Classifying
Circle Graphing	Predicting
Fractions	Recording Data

IV. Materials
one set of paper pentominoes for each student

V. Key Question
Which pentominoes can be folded into boxes without tops?

VI. Background Information
Eight pentominoes can be folded into boxes.


yes


no

VII. Management
1. This activity may take 30 to 45 minutes.
2. Five-Square is recommended as a preliminary activity. However, pentomino sets can be cut beforehand from the included master.

VIII. Procedure
1. Have the class hold up one pentomino at a time to make sure all students have a complete set of twelve pieces.
2. Ask the key question.

IX. What the Students Will Do
1. Students will estimate how many pentominoes can be folded into a box.
2. Students will attempt to fold each pentomino into a box using the established lines.
3. Students will record by drawing the pentominoes below the appropriate answer.
4. Students will count "yes" and "no" answers and color in the circle graph.
5. Students will write the appropriate fractions in the boxes.

X. Discussion
Do the pentominoes in the "no" group have something in common which makes a box impossible?

XI. Extension
Explore lines of symmetry. Which pentominoes can be folded to make one side fit on the other? Mark the folds that work.

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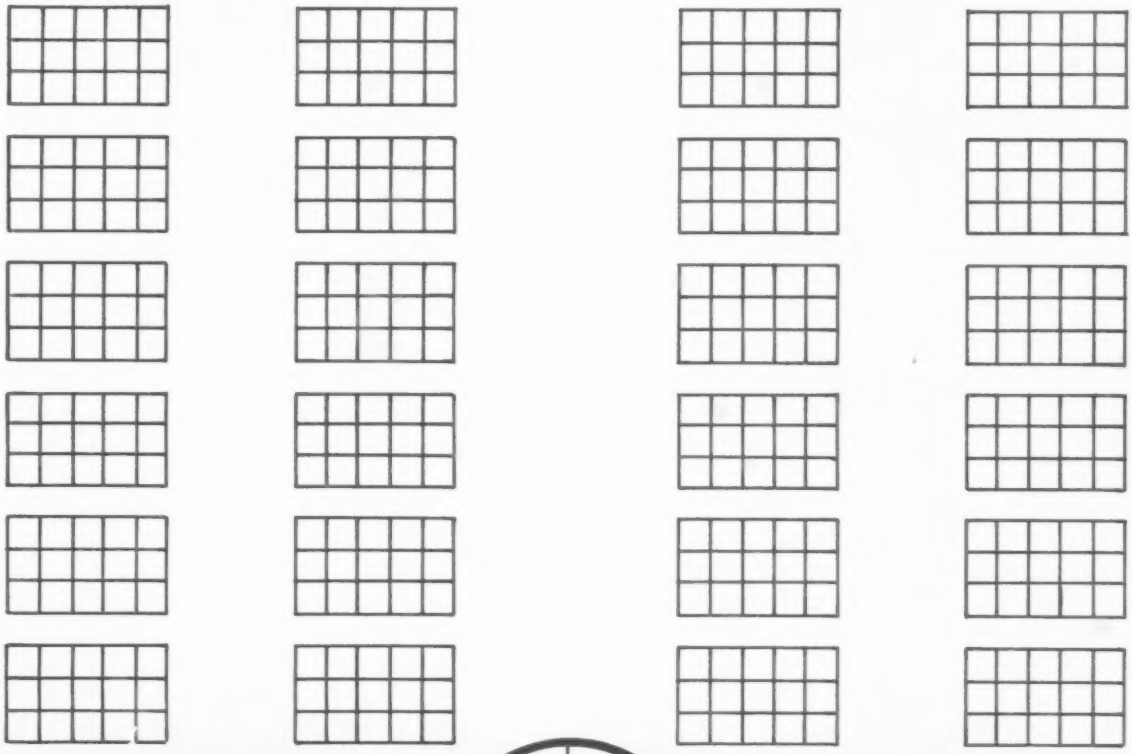
NAME _____

BOXED IN

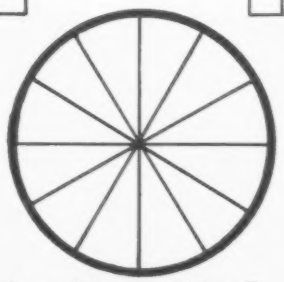
WHICH PENTOMINOES CAN BE FOLDED INTO BOXES WITHOUT TOPS?

ESTIMATE _____ ACTUAL _____

NO



THE FRACTION THAT CAN BE FOLDED IS



COLOR THE NUMBER OF PENTOMINOES THAT FORM A BOX.

THE FRACTION THAT CANNOT BE FOLDED IS

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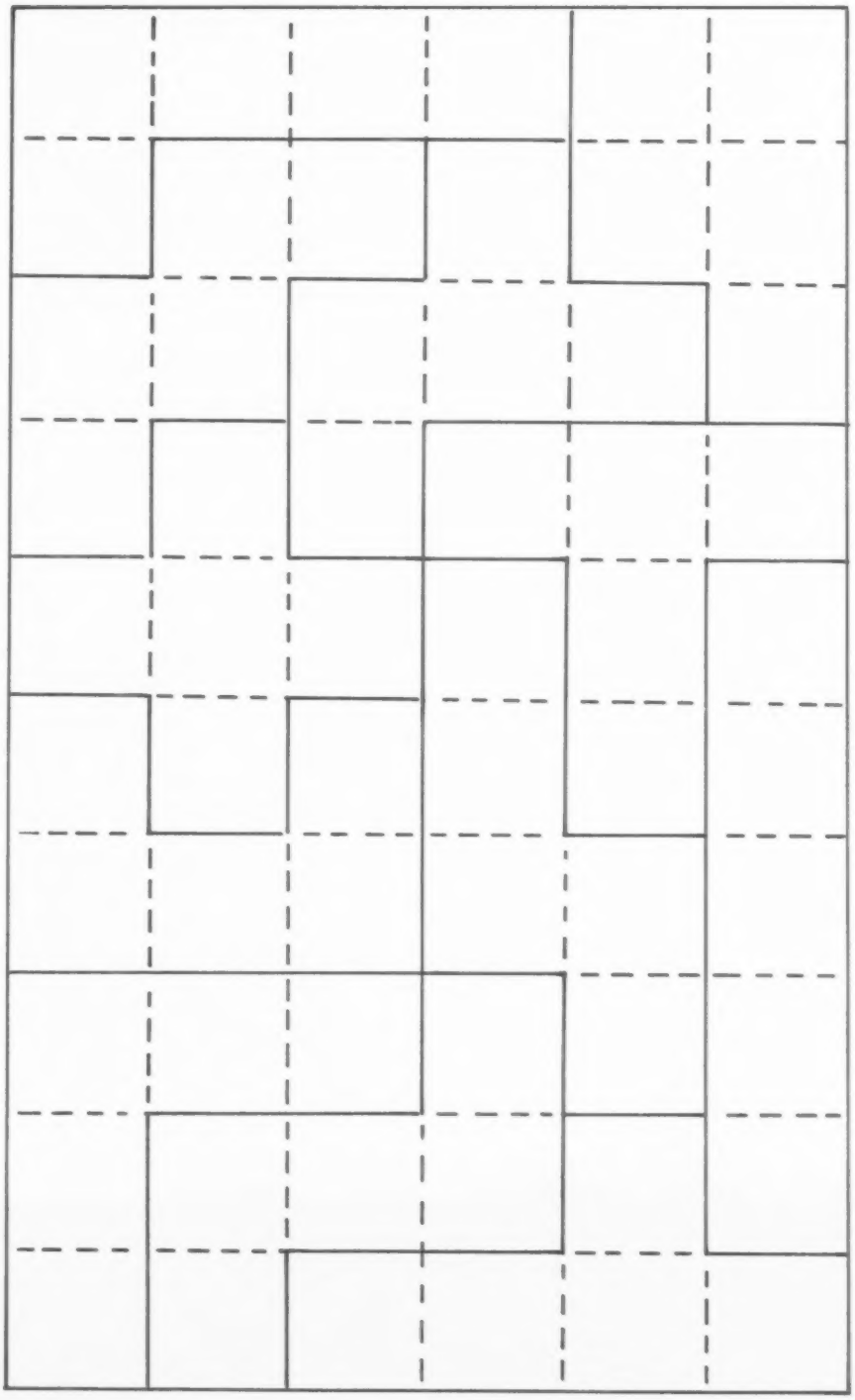
BOXED IN



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LET'S SPLIT

I. Topic Area
Geometry

II. Introductory Statement
Students will cut boxes into different pentomino shapes.

III. Math Skills
Geometric Patterns
Circle Graphing
Fractions
Estimating

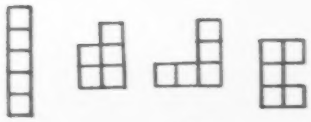
Science Processes
Gathering & Recording Data
Observing

IV. Materials
three or more lunch-size milk cartons per student
scissors
crayons

V. Key Question
Which pentominoes can be made when a milk carton is cut flat?

VI. Background Information
Of the twelve pentomino shapes, eight can be formed from open boxes.

yes



no

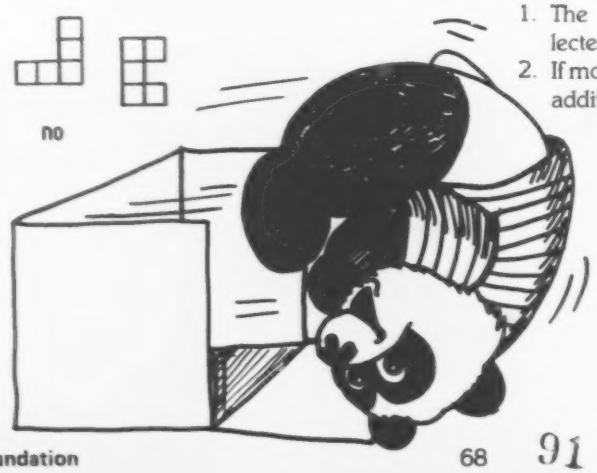
VII. Management
1. Save lunch milk cartons, rinse, and let dry.
2. This activity may take about 30 minutes.

VIII. Procedure
1. If students have not had prior experience with pentominoes, explain that they are five-squared shapes.
2. Pass out materials and have students cut down carton sides so they are about square.
3. After presenting the key question, ask what would be the simplest shape to cut. (the cross) Then encourage students to cut more unusual ones.
4. Show how to cut along the folded corners and keep the carton in one piece.

IX. What the Students Will Do
1. Students will predict how many pentomino shapes the class will cut from the cartons.
2. Students will cut one carton at a time into a flat pentomino shape and color it in on the activity sheet.
3. Students will compare milk cartons and record as many different results as possible.
4. Students will color the circle graph and write the appropriate fractions in the boxes.

X. Discussion
1. How many different shapes were found? Did we find them all?
2. Are these the same eight shapes found in Boxed In?

XI. Extension
1. The different carton pentominoes can be collected and displayed.
2. If more cartons are collected, each student can do additional cuttings.



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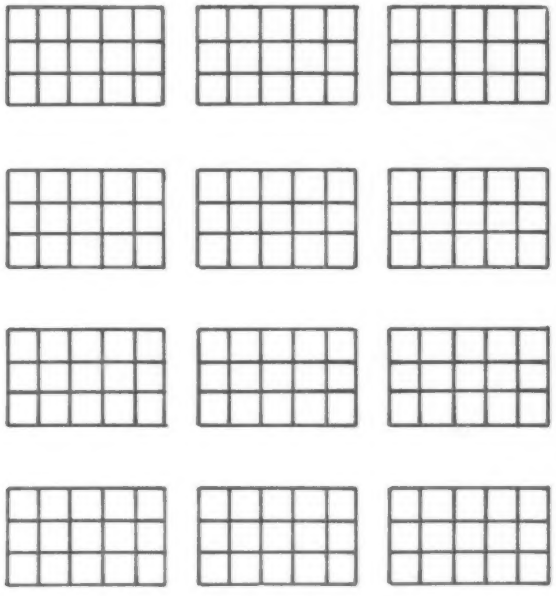
NAME _____

LET'S SPLIT

WHICH PENTOMINOES CAN BE MADE WHEN A MILK CARTON IS CUT FLAT ?

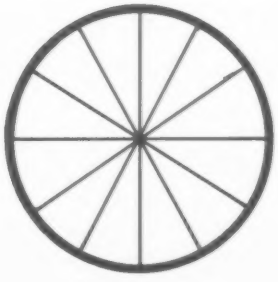
ESTIMATE _____ ACTUAL _____



THE FRACTION THAT CAN BE CUT IS:

THE FRACTION THAT CANNOT BE CUT IS:

COLOR THE NUMBER OF PENTOMINOES THAT CAN BE CUT FROM MILK CARTONS →



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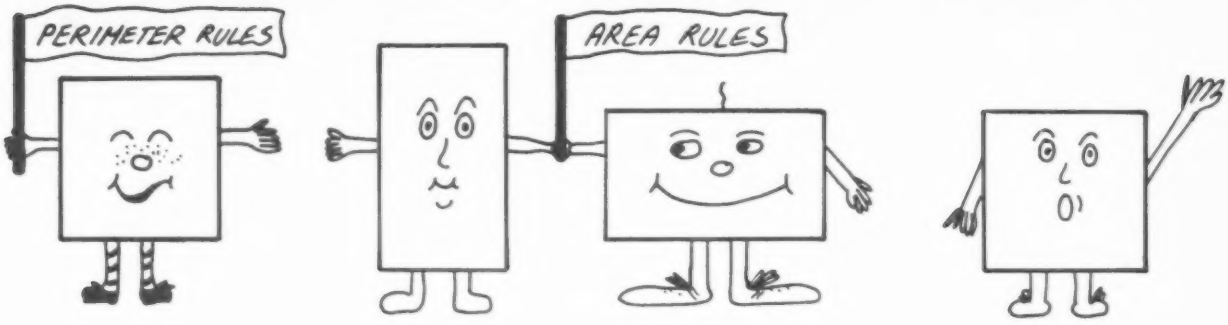
WRECK-TANGLES



I. Topic Area
Area and Perimeter of Rectangles

II. Introductory Statement
Students will be able to show that rectangles with equal perimeters do not have equal areas.

III. Math Skills
Area of Rectangles
Perimeters of Rectangles
Drawing Rectangles with Given Perimeters

Science Processes
Gathering Data
Recording Data
Drawing Conclusions

IV. Materials
string

V. Key Question
Do rectangles with equal perimeters have equal areas?

VI. Background Information
Rectangle - A quadrilateral with four right angles. Opposite sides of a rectangle are parallel and equal in length.
Perimeter - The distance around a polygon.
Perimeter of a rectangle equals two lengths plus two widths.
Area - The number of unit squares it takes to cover the inside of a figure.
Area of a rectangle equals length times width. Answer is always given in square units.

VIII. Procedure
1. Give each student 24 inches of string with the ends tied together to form a loop. Using fingers make different sized rectangles.
2. Using the grid at the bottom of the worksheet have students draw as many different rectangles as they can with a perimeter of 24 units.

HINT: To make this easier for students have them divide the perimeter in half. Since opposite sides are equal we can find the different lengths and widths by recording all of the addition facts equal to half the perimeter. These facts give us the numbers for the length and width.

3. Record data in the table finding the perimeters and areas. If students have not yet had experience multiplying length and width have them count the number of square units inside the figures.

IX. What the Students Will Do
same as above

X. Discussion
1. Is the perimeter the same for all rectangles in your chart?
2. Is the area the same for all the rectangles?
3. Describe the figure with the greatest area.

XI. Extension
1. Draw five rectangles with an area of 36 square units. Copy the chart and fill in the information.
2. Is the area the same for all these rectangles?
3. Is the perimeter the same for all these rectangles?
4. Which figure has the smallest perimeter?
5. What kind of rectangle is it?
6. What conclusions can you draw from these two experiments?
7. Make a new chart. Keep the width constant and increase the length one unit each time. How does this affect the area and perimeter?

XII. Curriculum Coordinates
1. Make a list of all the things around the room that are rectangles.
2. Use glue to form rectangles on construction paper. Let dry COMPLETELY. Make rubbings.

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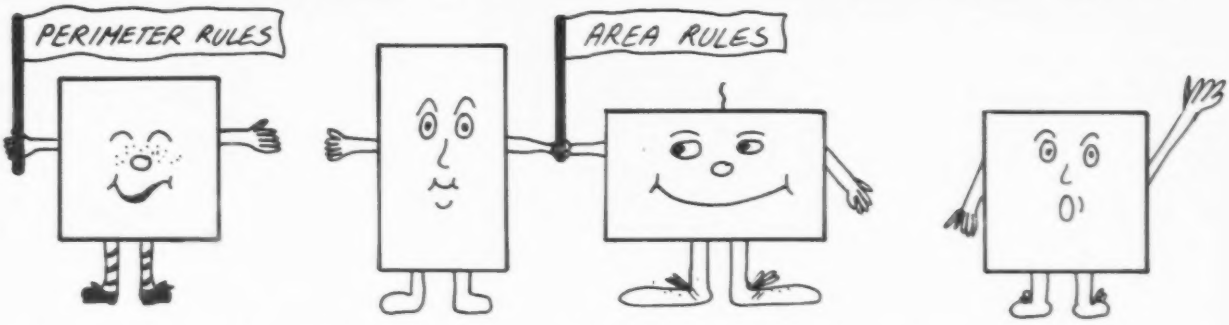
WRECK-TANGLES



DO RECTANGLES WITH EQUAL PERIMETERS HAVE EQUAL AREAS?

PREDICTION: YES NO

DRAW AS MANY DIFFERENT RECTANGLES AS YOU CAN WITH A PERIMETER OF 24 UNITS.

DID YOU FIND ALL SIX RECTANGLES?

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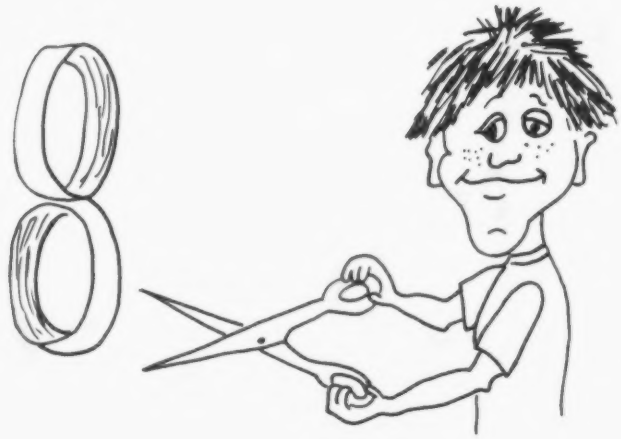
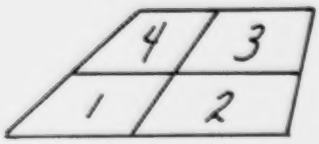
SLICE ME TWICE



	PREDICTED SHAPE	ACTUAL SHAPE	PROPERTIES OF SHAPE
EQUAL CIRCLES 90°			
UNEQUAL CIRCLES 90°			
EQUAL CIRCLES 45°			
UNEQUAL CIRCLES 45°			

PLAYGROUND GEOMETRY



I. **Topic Area**
Geometry

II. **Introductory Statement**
Students will gain practical knowledge of what "perimeter", "area", "radius", "diameter", and "circumference" are.

III. **Math Skills**
Measurement in Metric Units
Whole Number Computation
Geometry
Using a Formula

Science Processes
Measuring
Gathering & Recording Data

IV. **Materials**
meter sticks or meter tapes
trundle wheels

V. **Key Question**
How can you use your school playground to understand basic geometry?

VI. **Background Information**
none

VII. **Management**
This activity may take 60 to 90 minutes.

VIII. **Procedure**
1. Determine whether your playground has all the locations listed on the student sheet. "White out" and substitute your own, if necessary.
2. Divide the class into small groups, depending on how many meter sticks and trundle wheels are available.
3. Do whole-class examples of "perimeter", "area", "radius", "diameter", and "circumference" in the room before doing playground exercise.
4. Send the groups to the different areas for "perimeter" and "area", rotating the groups every 5-10 minutes through all the exercises.
5. Regroup together the whole class. Compare results. Discuss any differences in data.
6. Divide the class again into groups. Send the groups to different locations with circles and rotate as before. Regroup and discuss data.

IX. **What the Students Will Do**
1. Students will measure the length and width of playground locations and compute "perimeter", and "area" for each place.
2. Students will find four playground circles and measure "radius", "diameter", and "circumference" for each circle.

X. **Discussion**
1. What is "perimeter"?
2. What is "area"?
3. What is the difference between "perimeter" and "area" of an object?
4. What is "radius"? "Diameter"? "Circumference"?
5. What is the difference between "perimeter" and "circumference"?
6. How can you compare "radius" and "diameter"?

XI. **Extension**
1. Find other objects on the playground or in the classroom to measure.
2. Discuss how to find the area of a triangle. Find some triangles and find their areas.

XII. **Curriculum Coordinates**
Art: Watch the movie "Donald in Mathmagic Land". Make a picture using only geometric shapes.
Language Arts: Write a "square" poem inside a square shape, a "triangle" poem inside a triangle, etc.

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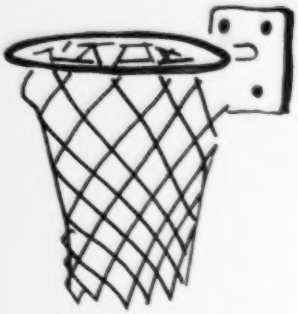
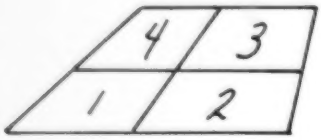
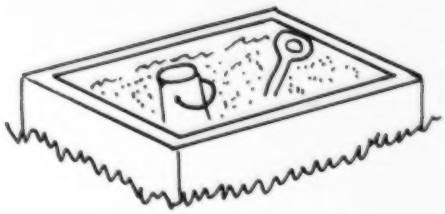
PLAYGROUND GEOMETRY







	LENGTH	WIDTH	PERIMETER L+W+L+W	AREA L X W
HOPSCOTCH OR GAME SQUARE				
4 SQUARE GAME				
SANDBOX				
BASKETBALL COURT				
BLACKTOP AREA				
SOCCER OR FOOTBALL FIELD				

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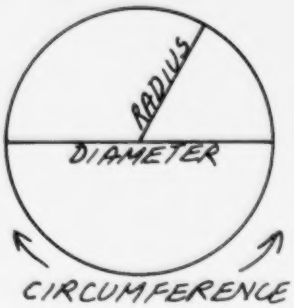
NAME _____

POSSIBLE PLAYGROUND CIRCLES



DODGEBALL
TIRE
TETHERBALL CIRCLE
MONKEY BARS RINGS
BASKETBALL COURT CIRCLES
BASKETBALL HOOP
GARBAGE CAN

1 _____
LOCATION

RADIUS _____
DIAMETER _____
CIRCUMFERENCE _____

2 _____
LOCATION

RADIUS _____
DIAMETER _____
CIRCUMFERENCE _____

3 _____
LOCATION

RADIUS _____
DIAMETER _____
CIRCUMFERENCE _____

4 _____
LOCATION

RADIUS _____
DIAMETER _____
CIRCUMFERENCE _____

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PATH FINDERS

I. Topic Area
Figures that can or cannot be traced without lifting your pencil.

II. Introductory Statement
Students will be able to determine when a figure can be drawn without lifting the pencil or retracing a line.

III. Math Skills
Even, Odd, Vertices
Networks

Science Processes
Observing
Gathering Data
Recording Data
Drawing Conclusions

IV. Materials
worksheet

V. Key Question
Find a rule that determines when a figure can be drawn without lifting your pencil or retracing a line.

VI. Background Information
A Swiss mathematician by the name of Leonhard Euler invented networks and discovered relationships that determine whether or not the networks can be traveled. The diagrams are called networks. The points where the lines cross are called vertices. A network is traveled or traced if it can be drawn without lifting your pencil or retracing a line.

Euler made four general discoveries about networks.

1. The number of odd vertices in a network must be even if it is to be traveled in one journey.
2. A network with all even vertices can always be traveled in one journey.
3. If a network contains 2, and only 2, odd vertices it can be traveled in one journey, but it is impossible to end up at the starting point. You must start your journey at an odd vertex and end at the other odd vertex.
4. If a network contains 4, 6, 8, 10, or any larger even number of odd vertices it is impossible to travel it in one journey. The number of journeys required is equal to half the number of odd vertices.

VII. Management
One class period.

VIII. Procedure
1. Let students try tracing all of the figures.
2. Indicate yes or no under each figure.
3. Discuss what a vertex is and what makes it odd or even.
4. Fill in table at bottom of page.
5. Give guided discussion and try to draw conclusions given in background information. (1-3)

IX. What the Students Will Do
same as above

X. Discussion
1. What is the point called where a line begins or ends? (vertex)
2. Can a figure be drawn without lifting your pencil if it has only two odd vertices?
3. Can a figure be drawn without lifting your pencil if it has only odd vertices?
4. Can a figure be drawn without lifting your pencil if it has just two even vertices?
5. Can a figure be drawn without lifting your pencil if it has more than two even vertices?
6. Can a figure be drawn without lifting your pencil if it has only even vertices?

XI. Extension
Draw at least three figures that can be drawn without lifting your pencil and three figures that cannot be drawn. Exchange with a friend.

XII. Curriculum Coordinates
Art: Color your figures. Divide your paper into sixteen squares. Put the same figure in each square. Make a repeating design by coloring.

Make up a story problem about traveling on this journey. Example: Ken wants to deliver his newspapers by traveling to each house once. How will he go? Give each line a value and find the total number of blocks he must ride his bike to complete his newspaper delivery.

The riders of the Pony Express had to travel their route quickly, so they looked for the shortest possible route.

If the scale of the map (figure) were one inch to three miles, how long would one journey be?

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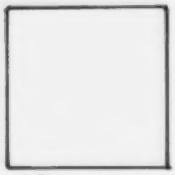
PATH FINDERS

STARTING AT ANY INTERSECTION, TRACE AROUND THE FIGURE WITHOUT LIFTING YOUR PENCIL OR CROSSING A LINE.

A

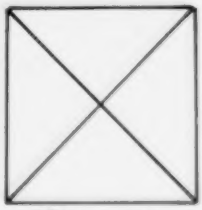


YES NO

B

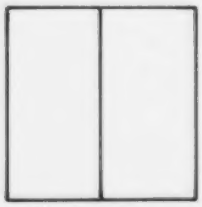
YES NO

C



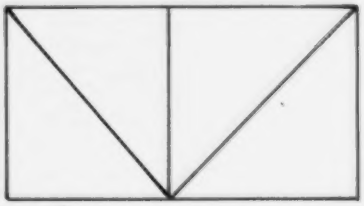
YES NO

D



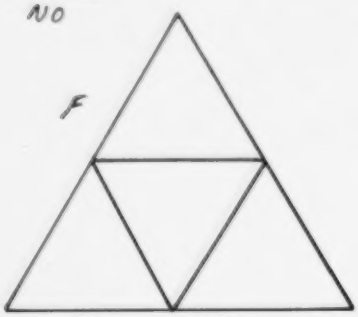
YES NO

E



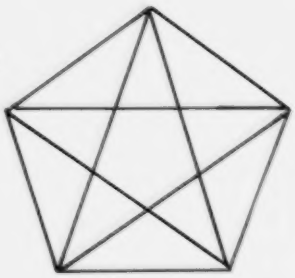
YES NO

F



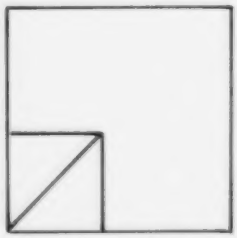
YES NO

G



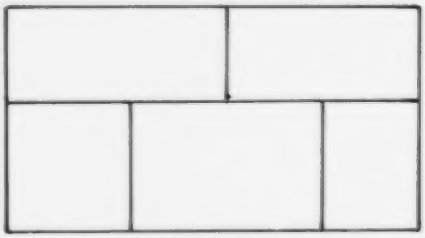
YES NO

H



YES NO

I



YES NO

NETWORK	A	B	C	D	E	F	G	H	I
# OF EVEN VERTICES									
# OF ODD VERTICES									
CAN IT BE TRAVELED?									

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SHAPING UP

I. Topic Area
Patterns in nature

II. Introductory Statement
Students will look at nature and man-made things for examples of different shapes.

III. Math Skills
Geometry
Recognize & Classify Shapes

Science Processes
Observing & Classifying
Gather & Record Data

IV. Materials
student worksheet
pencil

V. Key Question
"What geometrical shapes are there and how do man and nature disguise them?"

VI. Background Information
The difference between man-made and natural need to be clear in the students' minds.

On the student worksheet, in the boxes for lines, some possible answers could be Horizontal, Verticle, Diagonal, Intersecting, Circles, or Spirals.

In the boxes for shapes some possible answers could be Squares, Triangles, Rectangles, Pentagons, or Hexagons.

In the boxes for three-dimensional some possible answers could be Cubes, Spheres, or Cones.

VII. Management
This lesson will take approximately 40 minutes. It needs to be done on a clear day since the students will be outside.

VIII. Procedure
1. Discuss possible choices to put in the boxes for Lines, Shapes and Three-Dimensional.
2. Have the students think of two Natural and two Man-Made objects.
3. Write these objects in the boxes under the appropriate heading on the student worksheet.
4. The students are to check each Line, Shape or Three-Dimensional form that can be found in the named object.
5. Use the objects named in Step 2 only as examples. Each child should select their own. Every student worksheet will be different.
6. Have the students go outside and select their objects and mark the appropriate boxes.

IX. What the Students Will Do
1. Students will select two Natural and two Man-Made objects and record them on their worksheet.
2. Students will choose forms to place in the boxes for Lines, Shapes and Three-Dimensional and record on worksheet.
3. Students will check the forms that appear in their chosen objects.

		Natural Example		Man-Made Example	
		Tree	Field	Brick Wall	Desk
3 - D Shapes Lines	Horizontal	X	X	X	X
	Rectangle			X	X
	Cylinder	X			X

X. Discussion
1. What's the difference between Natural and Man-Made? (Natural objects would occur even if man weren't present.)
2. What Natural shape was hardest to find? easiest to find?
3. What Man-Made shape was hardest to find? easiest to find?
4. What shapes can you find in a tree, a river, the sky, etc?
5. What shapes can you find in a house, classroom, bicycle, etc?
6. How many Natural objects can you name that have squares, horizontal lines, circles, cubes, etc? Man-Made objects?

XI. Extension
1. Do the Geo-Panes investigation.
2. Search for Natural and Man-Made textures such as soft, hard, rough, smooth, fuzzy or prickly.

XII. Curriculum Coordinates
Art — Emphasizing one or two shapes, make a drawing. Include both Natural and Man-Made objects.
Language Arts — Pantomime some of the shapes you found.

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NAME _____

SHAPING UP

	NATURAL EXAMPLES		MAN-MADE EXAMPLES	
LINES				
SHAPES				

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MORE SHAPING UP

	3 DIMENSIONAL SHAPES			

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